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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 232*).

Forthcoming Events.

FEBRUARY 3.

Institution of Production Engineers (London Section):—Ordinary meeting. "Press Metal Work," Paper by J. L. Williams.

FEBRUARY 13.

Institute of Metals (Scottish Section):—Ordinary meeting. "Modern Light Alloys, with Particular Reference to Corrosion." Paper by L. Aitchison.

FEBRUARY 15.

Institution of Welding Engineers (London Branch):—Ordinary meeting. "Where Oxy-Acetylene and Electric Welding Join Forces," Paper by O. Simonis.

FEBRUARY 17.

Institution of Chemical Engineers:—Meeting at Hotel Victoria, Northumberland Avenue, London, at 2.15 p.m. "Metallurgy from the Standpoint of the Chemical Engineer," Paper by L. Singlehurst-Ward, B.Sc.

Institute of British Foundrymen.

FEBRUARY 3.

Birmingham and Coventry and West Midlands Branch:—Ordinary meeting at Birmingham. "The Open-Hearth Process for Steel Castings Production," Paper by W. H. Thompson.

FEBRUARY 4.

Lancashire Branch:—Annual dinner.

East Midlands Branch (Lincolnshire Section):—Ordinary meeting at Lincoln. "Shrinkage and Porosity in Grey Cast Iron," Paper by P. A. Russell.

FEBRUARY 8.

Lancashire Branch (Preston Section):—Ordinary meeting. "Coke: Its Properties and Uses," Paper by D. V. Hollingsworth.

FEBRUARY 9.

London Branch:—Ordinary meeting. "Mechanical Handling in the Foundry," Paper by A. W. G. Bagshawe.

The Foundry Exhibition.

After an interval of four years, the Foundry Trades Equipment and Supplies Association, with the co-operation of the Institute of British Foundrymen and the British Cast Iron Research Association, has decided to stage a comprehensive exhibition of foundry plant, raw materials and technique at the Agricultural Hall, Islington, London, from April 24 to May 3. The organisers, Messrs. F. W. Bridges, Limited, who now have offices in Grand Buildings, Trafalgar Square, inform us that the space is rapidly being taken up and that only a few island sites are available. There has been such a metamorphosis of industrial conditions since the last exhibition in 1929 that the exhibits in 1933 will have undergone a profound change. Many of the Continental foundry-equipment manufacturers have made arrangements for the manufacture of their specialities in Great Britain. Such geographical changes generally induce alterations in design and mechanical detail. Naturally there are some foreign suppliers who have deemed it wise not to manufacture in Britain on the grounds that they supply specialised plant, which can easily bear both the tariff imposed and the decreased buying value of sterling in their country. If the exhibition does show a decreased effort to sell on the part of the foreign supplier of foundry plant, current conditions should make well worth the time and expense of the foreign buyer visiting our shores, especially for those countries whose currency is linked with sterling.

The technical side of the exhibition is being handled by appropriate committees of the Institute of British Foundrymen and the British Cast Iron Research Association. *Inter alia*, there will be shown, by means of exhibits, the competition experienced by sections of the foundry industry from non-foundry products and the efforts being made to overcome them. Suggestions, by the way, for increasing the value of this part of the exhibition would be appreciated by the organisers, and we hold ourselves at the disposal of those who are in a position to contribute for transmission to the appropriate committee. For instance, one of the largest power-supply companies is now experimenting on a large scale with the replacement of very fine cast-iron fuse boxes by bakelite pressings or mouldings. Evidence as to any defects in the substituted product would be an appropriate exhibit.

As there is no convention, carrying with it technical sessions, receptions, works visits and so forth, there will be proper and adequate time for studying each exhibit carefully. We confess that even for us this has been sometimes a little difficult in the past. The characteristic feature of the 1933 exhibition is to be that of the showing by the suppliers of foundry equipment, raw material and services, what is available for improving the product of the foundry. The vast strides made in the last few years carries a warranty of the worth of a visit to town on this occasion.

Steel Castings.

The American Society for Testing Materials, jointly with the American Foundrymen's Association, has now issued the symposium of Papers on steel castings given at a joint meeting of the two bodies last year. The symposium is on very similar lines to the one issued previously on malleable irons, and these publications form part of a series designed to place before users and prospective users of the products concerned such technical data as are likely to be of service to them. There are about ten Papers. The introductory ones give a general survey and statistical data, and the remainder deal with such questions as design, purchasing requirements, physical and mechanical properties, alloy steels, heat-treatment and welding.

Some interesting facts emerge from the general survey. The steel-castings industry did not begin in the States until after the converter and open-hearth furnace had been developed to satisfactory commercial units. The electric-arc furnace was introduced to the industry in that country in 1909, and the converter and crucible furnace are apparently regarded as obsolescent. It is said that the largest steel casting ever produced in America was made in 1931, and weighed about 220 tons. The statistical data are extremely interesting, and taking the figures for 1929 as a peak year they support the view with respect to the disappearance of the converter and the crucible, for their combined output is only about 2 per cent. of the total. The open hearth produced about 70 per cent. of the total and the electric furnace the remainder. Acid- and basic-lined open-hearth and arc furnaces are used, but the acid lining appears to be preferred for both

units. The steel-castings output suggests that the industry is like the malleable industry, several times as large as the corresponding one of this country, and of the 300 plants which contribute to the output, over 80 per cent. of their output is produced in foundries supplying to the trade. Alloy-steel castings form about 11 per cent. of the total steel-castings output.

It appears that the most popular size of open-hearth furnace is that of 25 tons capacity, well over half the output being produced in furnaces of 20 to 30 tons. The most popular size of electric furnace is about 1½ to 3 tons capacity. The most popular size of converter is 2 tons capacity. It will be evident that the publication will be read with interest by all those connected with the production and use of steel castings.

Embrittlement of Low-Carbon Steel by Cold Work.

A report of the Materials Committee of the Association of German Ironmasters, by R. Walzel, of Donawitz, deals with the effect of various differences in the ingot on the tendency of ordinary soft un-killed basic open-hearth steel to become brittle on cold working. This was published in a recent issue of "Archiv für das Eisenhüttenwesen." This tendency was determined from the position of the temperature-impact value curves, on the one hand for the steel in the as-rolled condition, and on the other after 10 per cent. reduction by cold work of the depth of a rectangular bar, followed by tempering at 250 deg. C. Experience showed that for accurate determination of the position of the steep portion of the curve it was necessary to measure the impact value at seven different temperatures. Altogether some 1,400 determinations of impact values were made for the investigation. The material used was prepared from 30-ton heats made in a basic-open-hearth furnace, three each according to the following procedures: (1) One-third pig-iron, two-thirds scrap, no ore; (2) two-thirds pig-iron, one-third scrap, with the necessary ore addition; (3) pig-iron alone without scrap, and the necessary ore. All nine heats were deoxidised in identical manner with only ferro-manganese, no aluminium being used, the weight of the ingots being 3¾ tons. The carbon content was approximately 0.07 per cent. and the manganese approximately 0.40 per cent.

The tests showed that the tendency to embrittlement as indicated by the displacement of the temperature at which the impact values rose, *i.e.*, the brittleness was removed, was greater as the proportion of pig-iron in the charge increased, and also with increased segregation of the ingot and with larger grain size, the latter as the result of different annealing or tempering temperatures on unworked steel prepared according to the method (1), with one-third pig-iron in the charge.

Recovery of Iron in Slag.—A recent issue of "The Iron Age" states that a machine has been developed for removing the molten iron from the molten slag in blast-furnace or open-hearth operation. The iron is recovered by means of centrifugal force and the slag is then granulated, making for the recovery of the free iron in a usable form. In one instance over 2 tons of iron was recovered, although it seemed that no iron had been allowed to pass away in the slag stream.

New Alloys for Steel-making.—Recently three commercial steel-making alloys have been put on the market and are being produced in considerable quantity. These are as follow:—High-silicon spiegel (4 per cent. C; 20 Mn; 4 Si). Silicon spiegel (3 per cent. C; 30 Mn; 7 Si). Silico manganese (2 per cent. C; 70 Mn; 16 Si). A large tonnage of steel has been made with these alloys and the saving in ferro-manganese through their use is important.—"The Iron Age."

Death of Mr. H. G. Sommerfield.

We sincerely regret to announce the death of Mr. H. G. Sommerfield, the President of the London Branch of the Institute of British Foundrymen.

Mr. Sommerfield was elected last January, owing to the sudden death of Mr. H. C. Dews. In recent years, he took a great interest in municipal matters and was the chairman of the finance committee of the Finchley Council, and only recently was elected a common councillor for the Aldersgate Ward of the City of London, of which he was a Freeman and Liveryman. He joined the Institute of British Foundrymen in 1914, but as he was on active service, mainly in Egypt and Palestine during the war, he was not active until he was appointed honorary secretary of the London Section in about 1924. He was an original member of the Foundry Trades Equipment and Supply Association, and was at the time of his death its senior Vice-President. He began his career in the Civil Service, but later was on the staff of the Frodair Iron & Steel Company, where for a time he looked after their Scandinavian business. He left them to establish himself as a pig-iron merchant, but later extended his activities to include "safety-first" equipment and other lines. He was also the London agent for August's, Limited, of Halifax. Amongst his many other activities he was a very prominent Freemason. Mr. Sommerfield, who was a widower, was a man of extremely wide public interests, and in recent years their demand was such that he never had adequate time for recreation. It was a case of over-burdening a willing horse. Whilst he always looked fit and sturdy, those who, like ourselves, knew him very well realised that he was in reality of delicate constitution.

To his two step-children we tender our sincerest sympathy.

Industry and 40-hour week.

Report of Geneva Conference.

The international conference at Geneva, which has been examining the Italian Government's proposal for a 40-hr. working week, on January 25 adopted a report which will be submitted to the governing body of the International Labour Organisation and to the International Labour Conference, which meets on May 31.

The report sets out the arguments for and against the proposal. The arguments in favour of the reduction of hours of work were put forward mainly by the members of the workers' group, who emphasised the importance of employment being given to the greatest number of workers. It was claimed that the possible increase in costs which might result from the reduction of working hours would be offset by the increase in the purchasing power of the workers; by the decrease in the overhead charges per unit of production, and by the decrease and perhaps the disappearance of social charges represented by unemployment benefit.

The employers' representatives argued that the reduction of hours of work accompanied by an increase of hourly rates of pay would entail a considerable increase in production costs and selling price and result in a fall in demand calculated to produce fresh unemployment. The majority of Government delegates were of opinion that the proposal to reduce hours deserved the most serious consideration. While recognising there were very real difficulties, they nevertheless considered that it was desirable to undertake as thorough-going an examination of the question as possible. The British Government delegate declared himself against the institution of a 40-hr. week, since in his opinion the question of wages constituted a decisive obstacle, quite apart from the technical, economic, and other difficulties to which at the present moment the adoption of an acceptable convention on the reduction of hours of work would give rise.

Random Shots.

Has it ever occurred to you how little we know of the really big things in life? I mean, of course, the sun, the moon and the various constellations. (Aha! you thought I was going to moralise on Hard Work and Self-Help!) The fact is, the planets, with only their size to commend them, have become commonplace. If people like Sir James Jeans did not write books about them, we should forget that they existed. I admit that sailors make a great fuss of the stars. They use them to set their compasses, or sextants or watches—I forget which. Song writers and spring poets also do very well out of the moon. Writers of adventure stories occasionally send their heroes on a voyage to Mars. The sun is generally "on the front page" during the summer. The remaining planets, however, are complete nonentities. The average man, who lives in cities and rarely sees the sky, knows nothing of their extremely complicated movements.

* * *

For instance, if I were to ask you what happened on January 6, you would probably become blasphemous about income tax, or if you knew your calendar well, you would brightly remark that it was Twelfth Night and 359 days before 1934. The right answer, of course, would be that on that day Mercury was at inferior conjunction and Jupiter in opposition, its distance from the earth being 391,219,000 miles. Again, if I were to ask what happened last Monday, you might mutter: "Why bring that up?" If you really understood the great open spaces, you could tell me all about the sun's semidian on that particular day.

* * *

There are some who say that astronomical knowledge is of little use to a man in every-day life, but think what an impression you might create when, instead of leaving your fellow-passengers on the 8.20 with a description of that long putt at the 18th, or discussing with them the prospects of that 100 to 1 outsider in the 2.30, you might casually remark: "Hum, so to-day the sun encounters the sign Cancer (Summer Solstice). Well, well!" At once you would be stamped as a man of erudition. Again, consider the advantage of an astronomer when playing golf. Discarding our well-worn anathemas, he says "Orphinchus, Equaleus, Aquarius, Sagitarius!" or even "Orphinchus Capricornus Plaiader!" Thus, full vent is given to his feelings over a sliced drive, without any harsh words or misunderstandings. The same result, of course, can be obtained by anyone with a classical education. That is, I have always thought, the best reply to those who say that a classical education is of no practical use!

* * *

Another way of expressing one's feelings discreetly is that invented by a certain well-known church dignitary who always says "Assouan!" when he duffs his drive. Once somebody asked him why he said this. The bishop replied: "Assouan, sir, is the largest dam I know!"

* * *

For the above astronomical data I am indebted to "Whitaker's Almanack." Unfortunately its accuracy cannot be guaranteed for I have just discovered that my copy is two years' old!

Marksman.

According to the returns compiled by the Chamber of Shipping there was a decrease during the December quarter of 1932 of 111 in the number of vessels laid up at the ports of Great Britain and Ireland, and of 210,594, or 9.7 per cent., in the net tonnage. Of the total of 760 vessels of 1,971,101 tons laid up on January 1, 744 vessels of 1,934,536 net tons were British owned.

West Yorkshire Foundrymen at Dinner.

MR. JOSEPH HEPWORTH, J.P., M.P., ON TECHNICAL TRAINING.

The second annual dinner of the West Yorkshire Branch was held on January 14 at the County Restaurant, Bradford, when there was an excellent attendance of members and their ladies. Mr. A. S. Worcester (Huddersfield) presided. The chief guests were Mr. Joseph Hepworth, J.P., M.P. (director of Hepworth & Grandage, Limited, engineers and foundrymen, of Bradford), who was accompanied by Mrs. Hepworth, and Mr. T. Makemson (Manchester), Secretary of the Institute. Mr. Makemson was deputising at short notice for the Institute's President (Mr. Victor Stobie, M.I.E.E.), who, unfortunately, had been taken ill the previous day whilst on a visit to Middlesbrough.

Proposing a toast to "The Visitors," MR. S. W. WISE, hon. secretary of the Branch, said he had to convey the apologies of Mr. Stobie who, in intimating his unexpected inability to be present, sent kindly greetings and good wishes. Mr. Wise reported receipt also of a telegram of good wishes from Mr. Stubbs, President of the Lancashire Branch and Vice-President of the Institute. They were glad to welcome that evening Mr. and Mrs. Hepworth and Mr. Makemson, who had so generously answered the emergency call. They were glad to welcome also several members of other Branches, some of whom had lately come into West Yorkshire, and among whom he was personally glad to mention Mr. Young, Past-President of the Newcastle Branch. Mr. Neath, late secretary of the Birmingham Branch, was one whom they had gladly welcomed into their West Yorkshire membership, and one to whom they wished every success in his coming to Keighley to join Mr. Poole in Keighley Laboratories, Limited.

The Institute, said Mr. Wise, in the space of less than 30 years had grown to be a chartered Institute mustering nearly 2,000 members, spread over all parts of the world wherever foundry work was practised. There had been great changes in the mental outlook of the craft in those 30 years, and much of it was due directly to the splendid work of those who founded it. They were glad to welcome Mr. Makemson, who had taken hold of the national Secretaryship at a time of very great difficulty and who had had no light task in pulling things round from what had become a somewhat chaotic state of affairs. Mr. Makemson was also honorary secretary of the Foundrymen's International Technical Committee, and therefore had exceptional knowledge of affairs, which was of very real value to the Institute. In Mr. Hepworth they not only had one of their own area Members of Parliament, but a man of great engineering ability and closely identified with their own industry.

Institute's Progress.

MR. T. MAKEMSON, Secretary of the Institute, replying to the toast in the absence of the President, said they were all delighted to learn that they were joining in the celebration of Mr. Wise's 21st membership anniversary. The Institute, a body of which the members had every reason to be proud, had in recent years made special endeavours to widen its work in the direction of direct usefulness to foundrymen. Much of this effort was through the development work of certain of its committees. The final object was to make the results of research utilised by the average foundryman in his daily work. One important committee had already made a Report and others were to follow in what he believed would be a valuable stream of information and guidance relating to every phase of foundry practice. He would like to stress the point that this valuable work was being done entirely voluntarily by the men concerned; not only were they working for the love of it, but at their own expense, and it was up to the members, as a whole, to give them every encouragement by loyal support so that their work should redound to the good of the whole industry.

It was true, proceeded Mr. Makemson, that a good many technical societies and institutes had the privilege—largely through the status conferred by age—of carrying with their membership a kind of recognition of professional qualification by virtue of such membership. The Institute of British Foundrymen, although it now held a Royal Charter, could hardly claim to have reached that stage as yet; but there was compensation for this in the fact that it could not be said that any member of that Institute was in it for the sake of any personal professional status it might carry, but because they were keenly interested in helping to further the interests of the technical side of their industry.

Technical Training.

MR. JOSEPH HEPWORTH, J.P., M.P., proposed a toast to the West Yorkshire Branch of the Institute. Personally, he was particularly glad to be present that evening, because he felt very much at home amongst people who were connected with an important section of the industry which was his own means of livelihood. He did not want to talk a lot of "shop" on an occasion of that kind, but he did want to say that, while he had some little knowledge of foundry practice—acquired from practice in his own firm's foundry and from a good deal of general observation as an engineer—he fully realised that there were men present who were "miles ahead" of him in foundry knowledge, and who had probably forgotten more than he ever knew. He thought, however, it was an occasion on which he might speak quite frankly in the hope that he was speaking with a desire, like all present, to encourage and help the foundry industry. It had always seemed to him that there was no part of the engineering trades in which there was—or had been perhaps until recent times—a more marked lack of co-ordination between the chemist and the moulder on the one hand, and between those two individuals and the draughtsman and engineer on the other. The moulder was usually a very practical man who did not get his knowledge and ideas down on paper for future reference and guidance; whilst in the case of the chemist his ideas frequently got little further than paper because he so often lacked the practical experience and outlook. The moulder therefore got little or no knowledge of what the chemist required. As to the engineer, there were again two types—the practical and the theoretical. Sometimes, but too seldom, these types were blended. Whilst it was not uncommon to find that the two types of engineer managed to understand and appreciate each other, it was noticeable that neither type of engineer had commonly a clear appreciation of what the chemist or the moulder had to do. Frequently a drawing or design was produced which was very impracticable from the point of view of the man who had to make the mould and produce a perfect casting. It may be equally impracticable in the opinion of the chemist who needed to produce a metal which would be in its best condition in important parts of the casting and, at the same time, in a passable condition in all other parts of the same casting. One could cite dozens of such examples in every branch of engineering practice.

"The remedy for this state of affairs," proceeded Mr. Hepworth," was not an easy one to outline. Each man's branch of knowledge, be it practical or theoretical, was more or less a life's work, and nothing was more dangerous than the man who thinks he knows the other man's job better than that individual himself. What education needs to teach a man is sufficient knowledge of the other man's job so that he can collaborate, and those responsible for technical education will serve the purpose of industry best by working along these lines. There was very little doubt that every school of advanced instruction should possess a foundry and pattern shop. The major function of this place would, naturally, be to teach moulders the more theoretical side of their craft. An equally valuable activity would be to teach chemists and metallurgists the principles on which the moulder works, and to show engineers not only how a mould is made but also how definite laws exist concerning extremes of thickness of section affecting segregation, porosity, cooling stresses and so on. In this manner each can be educated to appreciate the knowledge of the other.

Lack of Suitable Teachers.

"One difficulty, however," continued the speaker, "was that educational authorities themselves were so often too theoretical and tended to place undue weight upon a student's ability to memorise data in order to pass an examination.

"Before we get educated people with practical ideas coming into industry, we shall need to appoint educationists with practical ideas to teach them. This is not to say that we lack such men, because happily there are many of them, but the time has not yet come when they are in the majority. Anybody glancing through the curriculum of almost any technical college will see that it is composed largely by the theorist to suit his needs and with small appreciation of the practical needs of the industrialists. He suggested, therefore, that the Institute of British Foundrymen could hardly do better work than appeal to those in authority to provide means of technical education on the lines outlined and, so far as possible, to depart from tests by examination unless it be examination of a very practical character, with the elimination of catch-questions or those depending mainly on a student's ability to memorise something of small practical value. He was only concerned to see that the young men get the right type of training to enable them to compete in the markets of the world. There never was a more imperative need, than in this day of intense competition, for the best that we can get in technical education. It is, indeed, essential if this old manufacturing country of ours hopes to regain its industrial lead. The object of the Institute is to gather and collate the results of research and scientific information relating to your craft and pass it on in a form of practical working value to those engaged in daily foundry practice. This is a most important work. Whenever he heard talk of economy in matters of education—and especially of technical education—he felt it was a step in the wrong direction. After all, whatever success or achievement we may gain in the arts and the professions they are actually the sidelines of life—desirable enough in themselves—dependent in the end on the prosperity of practical industry. Unless industry succeeds these others are *non est*, because they depend on the wealth-productive capacity of the country's industry."

Turning to the question of the condition of trade, MR. HEPWORTH said 1932 had been a disappointing year for many. It had been a year in which the long industrial depression had continued; but, personally, he was quietly optimistic about 1933. He was not going to phophecy any boom but he felt confident that a more buoyant spirit was in evidence and that we should have a revival in trade and industry in the near future. He believed we had got past the worst and were at present, so to speak, in the troubled waters which followed the storm,

(*Concluded on page* 96.)

Aluminium Bronze.*

By Frank Hudson.

It is some five or six years ago since the author first became interested in this alloy as an alternative to manganese brass for incorporating into those parts of engineering structures subject to failure by "corrosion fatigue." It is fairly well recognised that manganese brass and other high-tensile zinc-bearing brasses are prone, under certain corrosive conditions, to become "dezincified," when their efficiency as a member of any structure is most seriously impaired. In fact, when the above condition is brought about, failure of the affected part is liable to occur with minor applications of stress. This is aggravated considerably if the material should happen to possess an all-"beta" structure. Even without the presence of corrosion many of the high-tensile brasses have inadequate resistance to fatigue stresses. This problem of corrosion fatigue is of paramount importance to those interested in the control of water power,

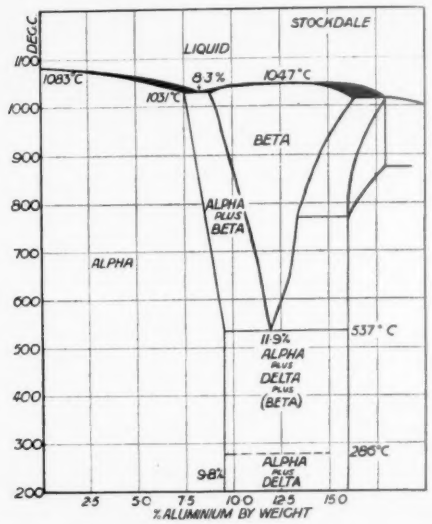

FIG. 1.—A PORTION OF THE COPPER ALUMINIUM EQUILIBRIUM DIAGRAM COVERING THE ALUMINIUM-BRONZE COMPOSITIONS.

and Messrs. Glenfield & Kennedy, with whom the author has the honour of being associated, decided that aluminium bronze should be adopted for replacing those parts of their manufacture liable to failures of this nature. From adoption to production was a natural sequence, and it is intended to comment freely on production problems.

It is not proposed to deal with the historical side of this alloy except to mention that, as a nation having a lead on fundamental research, it is to be regretted that we have left the practical application largely to foreign enterprise, notably American. It is interesting to record that in the "Brass World," for April, 1905, is described the use of aluminium bronze for firing pins on the old Springfield rifle. Apparently, steel would not stand up to this service, and the United States Government had a special specification drawn up to cover the necessary requirements. This was no doubt before the advent of the modern alloy steels.

Going further back even than this, it appears that in October, 1886, nearly 50 years ago, that an order for several tons of aluminium bronze completed by the Cowles Electric Smelting & Aluminum Company, of Cleveland, Ohio, U.S.A., gave a tensile strength in the ingots ranging from 46 to 55 tons per sq. in. This company described themselves as "the only electric smelters in the world," and were apparently one of the first to produce aluminium on a commercial scale. They described their product as follows:—"Aluminium bronze, now for the first time produced at a cost permitting

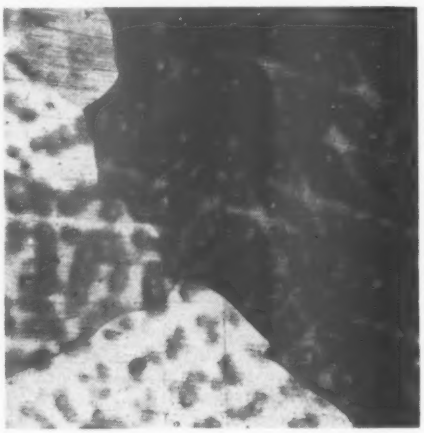

FIG. 2.—4.64 PER CENT. AL, 1.04 PER CENT. FE, 0.80 PER CENT. MN. AS SAND CAST. × 40.

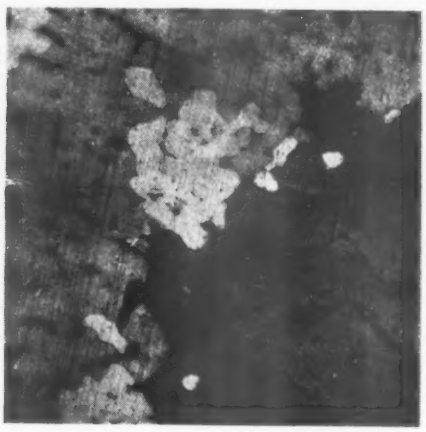

FIG. 4.—6.59 PER CENT. AL, 1.23 PER CENT. FE, 0.75 PER CENT. MN. AS SAND CAST. × 40.

of its general and widespread use, is destined to occupy a prominent and influential position in the standard metals of the world. It is a true chemical compound, and possesses the superior qualities of:—Great tensile strength (45 tons per sq. in.); malleability and ductility; high resistance to compression; transverse strength or rigidity (40 times greater than brass); fine founding qualities; hardness, softness, or toughness, as required (obtained by tempering); susceptibility to fine finish; brilliancy and lustre; sonorousness and homogeneity; high electrical resistance; power to transmit heat; and resistance to galvanic action in liquids."

In giving credit to the part foreign enterprise has played in the practical application of aluminium bronze, it must not be forgotten that it was a British scientist who discovered the alloy, namely, Dr. John Percy.

Whilst aluminium bronze is universally recognised as an alloy of great promise, its extensive adoption has been no doubt hindered through a misunderstanding of those points of metallurgical technique required for practical working. The intention of this Paper is to elucidate those points. Comment will be made on the constitution of the aluminium bronze group from the practical application of the equilibrium diagram followed by an illustrated outline of the more important points connected with successful manufacture of castings and large forgings. Special attention will be given to the difficulties one is liable to encounter, such as oxide segregation, self-annealing, etc., and the methods employed to overcome these. The value of this material under corrosive conditions, in comparison with other non-ferrous alloys will be discussed together with its physical properties in the cast, as forged, and heat-treated condition. The Paper will conclude with an outline of the uses for aluminium bronze in the world to-day.

Equilibrium Diagram.

A portion of the diagram, after Stockdale, is shown in Fig. 1. Stockdale's work in this direction is invaluable and reference should be made to his Paper "The Copper-Rich Aluminium-Copper Alloys" ("Journal Institute of Metals," Vol. 28, 1922, p. 273) for complete information. This diagram is generally accepted as the most authoritative, but it should be clearly pointed out that it is based on alloys under equilibrium conditions. In ordinary foundry work the rate of cooling is not slow enough to give equilibrium conditions, and consequently in

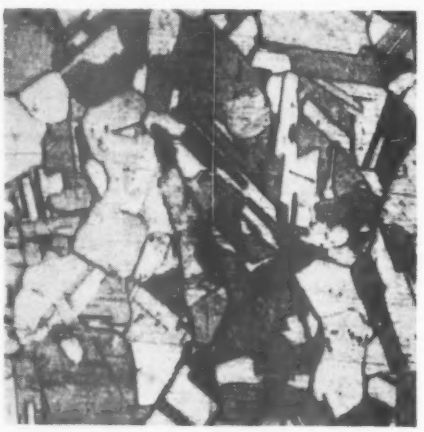

FIG. 3.—AS NO. 2. × 340. FORGED AND ANNEALED.

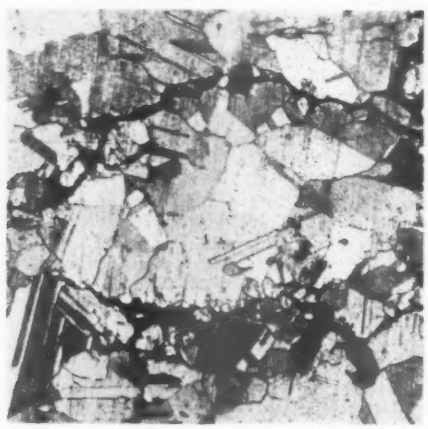

FIG. 5.—AS FIG. 4. FORGED AND ANNEALED. × 240.

* A Paper read before the Scottish Branch of the Institute of Metals, Dr. Hay presiding. The Author is Chief Metallurgist to Glenfield & Kennedy, Limited.

practice the aluminium bronzes do not strictly follow the diagram. The difference between the theoretical and the practical is of such magnitude that very serious trouble can arise unless one fully appreciates the necessary departure required to meet successful works practice. Furthermore, the published information on these alloys is extraordinarily vague about this point, and the author is unaware of any exact work having been conducted which could be accepted as a suitable guide to the practical worker. Thus it would seem profitable to devote some space to the outlining of the limits of departure as

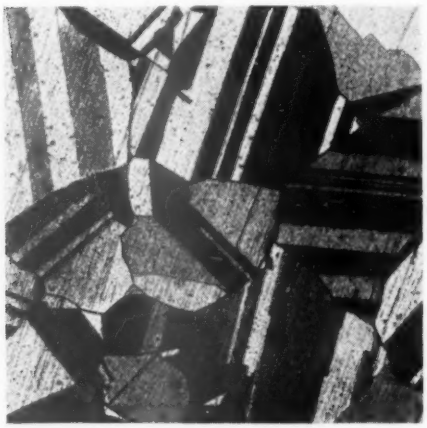

Fig. 6.—As Fig. 5. Reheated 950 deg. C. for 1 hr. Cooled slowly in Furnace over 8½ hrs. × 100.

found by results obtained in the laboratory and foundry. In the first place, the commercial aluminium bronzes do not contain more than 16 per cent. aluminium.

Referring for a few moments to Stockdale's diagram as shown in Fig. 1, it will be observed that alloys within this range can be composed of one or more of three phases or metallographic constituents, such as the "alpha" phase,

Fig. 7.—As Forged. Water Quenched 950 deg. C. × 500.

"beta" and "delta." Alloys containing up to 7.5 per cent. aluminium are only made up of a single solid solution of aluminium in copper. This is known as the alpha phase. This phase, furthermore, exists in alloys containing up to 9.8 per cent aluminium when at atmospheric temperatures, or up to a temperature limit of 537 deg. C. Alloys between 7.5 and 9.0 per cent. aluminium, upon cooling from the liquid state have an alpha plus beta structure existing at temperatures between 1,031 deg. C and 750 deg. C. respectively according to the percentage of aluminium present. On further cooling this combined phase reverts to the single alpha solid solution. Between 9.0 and 9.8 per cent. aluminium the single beta-phase is first formed on cooling which changes to the combined alpha-beta phase between 1,031 deg. C. and 925 deg. C. On still further cooling, the alloys between 9.0 and 9.8 per cent. aluminium at respective temperatures of approximately 750 deg. C. and 537 deg. C. revert to the single alpha phase. In the author's opinion this part of the equilibrium diagram for alloys containing up to 9.8 per cent. of aluminium is the most important so far as the bulk of practical application is concerned, as within this range one safely obtains those necessary qualities required for resisting fatigue.

It will be noticed that up to this point the existing phases have been either alpha, alpha plus beta or beta. The third phase of delta does not exist in alloys containing up to 9.8 per cent. aluminium. Exceeding 9.8 per cent. aluminium the beta phase predominates at high temperatures, which on cooling reverts to the combined alpha-beta state until 11.9 per cent. aluminium is reached. At this point the beta phase ceases to precipitate the alpha constituent, forming the delta phase instead. These changes under equilibrium conditions are complete at a temperature of 537 deg. C. At this temperature a transition occurs quite parallel to that of the formation of pearlite in the iron-carbon diagram,

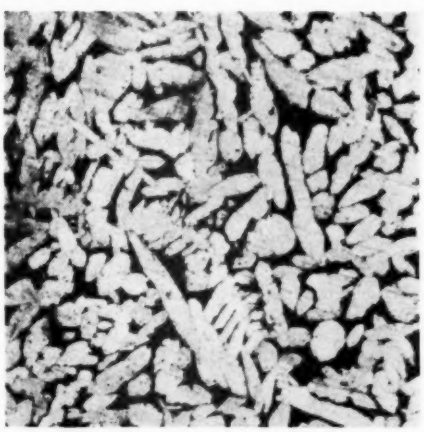

Fig. 8.—8.63 per cent. Al, 1.46 per cent. Fe, 0.72 per cent. Mn. As Sand Cast. × 100.

namely, a change of the alpha plus beta phases into an eutectoid mixture of the alpha solid solution and delta. This change is the direct cause of that defect common to the aluminium bronzes known as "self-annealing" to which further reference will be made later. Under true equilibrium conditions the phases existing theoretically is the aluminium bronzes at atmospheric temperature are:—Alpha phase in alloys containing up to 9.8 per cent. aluminium, and alpha plus delta in those alloys containing between 9.8 and 16.0 per cent. aluminium. Before leaving this diagram it should be pointed out that one of the most prominent general features of this system is the extremely small range of solidification which is of technical importance in as much as the alloys freeze quickly and this consequently prevents serious segregation in large castings.

A proper knowledge of the diagram is really essential for the successful manufacture of alloys in the aluminium-bronze group, for with its help one can produce from material of specified composition a structural condition best suited for any particular service. This is of particular moment when one is handling an alloy susceptible to heat-treatment and the consequent effect of mass and cooling conditions. Since, as previously mentioned, in ordinary foundry work the rate of cooling is not slow enough to give the conditions of equilibrium as represented in the diagram, one generally finds the existing structure present in any alloy quite different to that shown in the equilibrium diagram.

This particularly applies to alloys containing between 6.5 and 10.5 per cent. aluminium, incidentally the range most widely used commercially. Furthermore, the alloys of commerce often contain slight percentages of impurities and additions of other metals added for special purposes, which make a slight departure from the diagram necessary. In order for one to obtain an idea of the alteration in structure likely to arise, the following example is cited:—

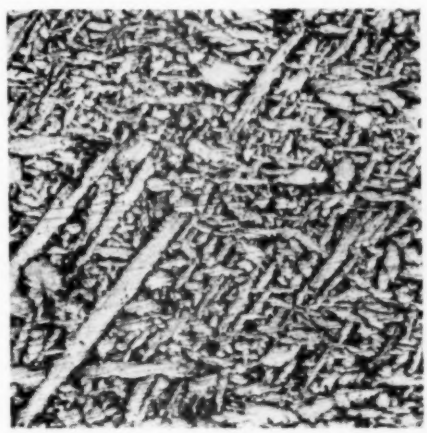

Fig. 9.—As Fig. 8. Forged and Annealed. × 100.

A sand-cast test-bar, 1¼ in. dia., containing 6.59 per cent. Al, 1.23 per cent. Fe, and 0.75 per cent. Mn, under the microscope showed the first indication of an alpha-beta structure. According to the diagram, the first indication of an alpha-beta structure should not occur until 7.5 per cent. Al is reached. The occurrence of the alpha-beta phase at the lower aluminium content is probably mainly due to cooling conditions being more rapid than those necessary

Fig. 10.—10.39 per cent. Al, 1.12 per cent. Fe, 0.76 per cent. Mn. As Sand Cast. × 100.

to obtain equilibrium. As the cooling conditions approach equilibrium, the structural phases tend to coincide with those shown in the diagram.

Fig. 2 shows the "as-sand-cast" structure of an aluminium bronze containing 4.64 per cent. Al, 1.40 per cent. Fe, and 0.80 per cent. Mn. This structure is composed entirely of the alpha phase and is the form generally assumed by a cast structure.

Fig. 3 shows the structure of the alpha constituent after being forged and annealed at 650 deg. C. for ¼ hr. and cooled in air. The

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photograph is magnified 340 times. In comparison with the previous slide it will be noticed that the forging and annealing treatment has removed the "cored" structure and refined the grain. The alpha constituent is golden yellow in colour and forms twinned crystals readily when worked and subsequently reheated. Normal aluminium bronzes having an aluminium content below 6.6 per cent. are composed entirely of the alpha phase. They are not amenable to heat-treatment, and in the cast state give the lowest maximum strength but best ductility. At the same time, some quite excellent properties can be obtained by suitable working.

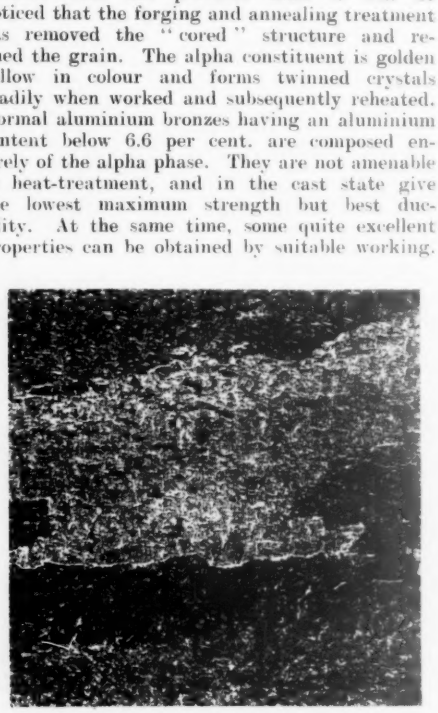

Fig. 11.—As Fig. 10. Forged and Annealed. × 100.

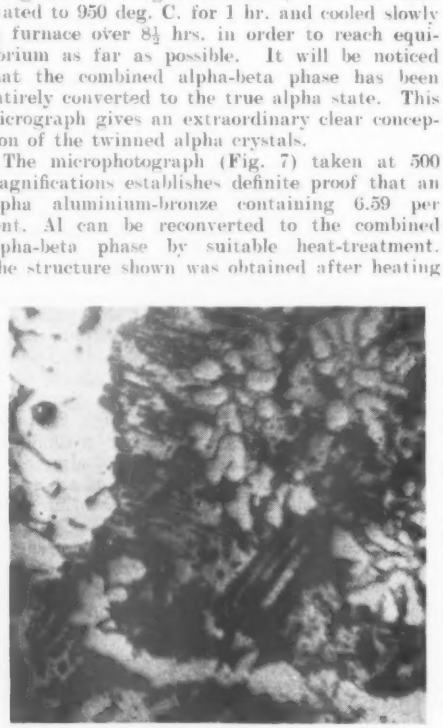

Fig. 13.—As Fig. 12. Forged and Annealed. × 500.

Fig. 4 shows the microstructure of an aluminium bronze containing 6.59 per cent. Al, 1.23 per cent. Fe and 0.75 per cent. Mn, magnified 40 times. The section is taken from a 1¼-in. dia. sand-cast bar, and illustrates the beginning of the alpha plus beta phase. The beta phase is represented by the dark patches in the photograph. Beta is hard and moderately

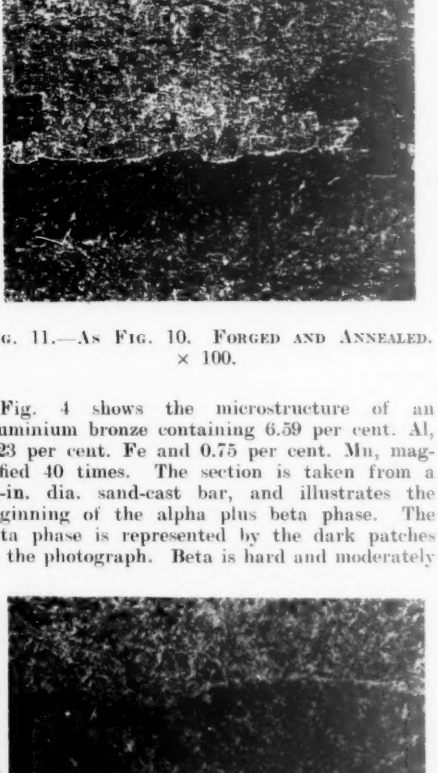

Fig. 12.—12.53 per cent. Al, 1.59 per cent. Fe, 0.17 per cent. Mn. As Sand Cast. × 100.

brittle. Fig. 5 shows the structure of the previous alloy after forging down to 1-in. bar and annealed at 650 deg. C. for ¼ hr. and cooled in air, magnified 240 times. The twinned alpha structure is readily noticed, while the dark beta phase surrounds a group of alpha crystals.

The two previous photographs (Figs. 4 and 5) suggest an interesting example of the presence of the combined alpha-beta phase in an alpha alloy due to restricted cooling conditions and absence of equilibrium, as mentioned when discussing the equilibrium diagram. Fig. 6, taken at 100 magnifications, is similar to the last, being in the forged condition, but has been heated to 950 deg. C. for 1 hr. and cooled slowly in furnace over 8½ hrs. in order to reach equilibrium as far as possible. It will be noticed that the combined alpha-beta phase has been entirely converted to the true alpha state. This micrograph gives an extraordinary clear conception of the twinned alpha crystals.

The microphotograph (Fig. 7) taken at 500 magnifications establishes definite proof that an alpha aluminium-bronze containing 6.59 per cent. Al can be reconverted to the combined alpha-beta phase by suitable heat-treatment. The structure shown was obtained after heating a forged section to 950 deg. C. for 1 hr. and quenching in water. The golden yellow colour of the alpha phase is readily recognised against the dark beta surrounding the alpha crystals. This photograph, and the immediate previous one, were obtained on ½-in. dia. sections. Passing from the border alloy containing 6.59 per cent. Al the subject reaches the full alpha-beta

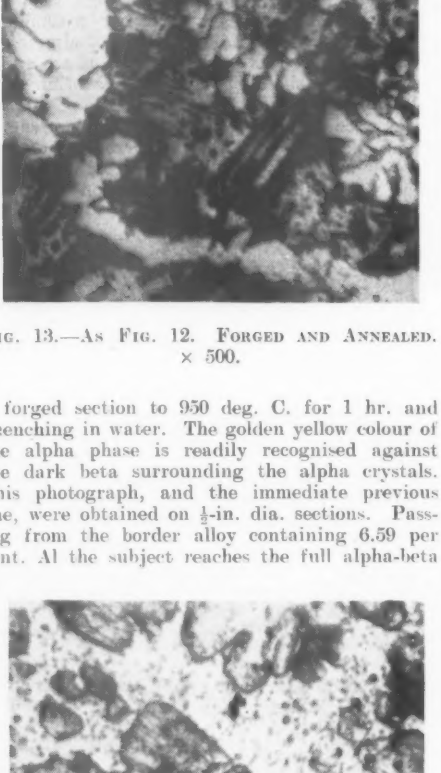

Fig. 14.—13.93 per cent. Al, 1.29 per cent. Fe, 0.51 per cent. Mn. As Cast. × 500.

structures as shown by material containing 8.63 per cent. Al, 1.46 per cent. Fe and 0.72 per cent. Mn. This micrograph, at 100 magnifications, is typically representative of a sand-cast alpha-beta bronze.

Fig. 9 illustrates the previous alloy after forging and annealing at 650 deg. C. for ¼-hr. and air-cooled. The photograph is magnified 100 times. Fig. 10 shows the sand-cast structure of an alloy containing 10.39 per cent. Al, 1.12 per cent. Fe and 0.76 per cent. Mn. The section of the ingot is 1¼ in. dia. and the structure typically one of the combined alpha plus beta phase. It is magnified 100 diameters.

The micrograph (Fig. 11), taken at the same magnification as the last, represents the structure obtained after forging the 10.39 per cent. Al alloy, and annealing at 650 deg. C. for ¼-hr. and air-cooled. The structure is bordering on the full beta-phase, this being brought about by too-rapid cooling conditions in conjunction with composition and section. The full beta-phase is not a good condition for engineering structures to have, as whilst they possess greater hardness over those exhibiting an alpha-beta structure, they fall short in fatigue-resisting properties and are liable to failure under repeated shock or impact. This particular photograph is another interesting example of the results obtained in practice not conforming to the equilibrium diagram, due to the absence of equilibrium conditions, and points out a lesson in the need for exercising care in selecting composition for the higher aluminium content

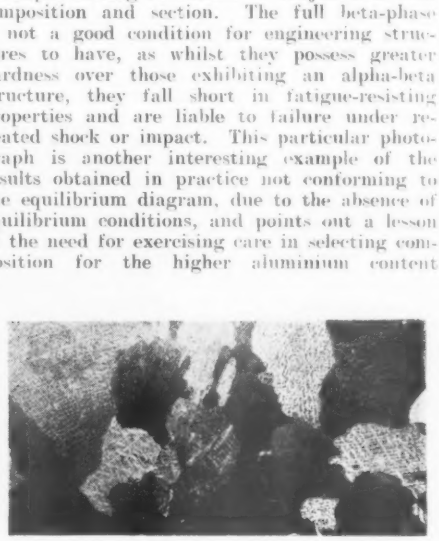

Fig. 15.—Appearance of Etched Surface of Sand-Cast Sections. Top, 4.64 per cent. Al; middle, 6.95 per cent. Al: bottom, 10.39 per cent. Al. × 3.

bronzes, especially when sections of 1 in. and below are present. Personally opinion is that when 10 per cent. of aluminium is reached or exceeded, very great care must be exercised to prevent brittleness.

Fig. 12 shows the sand-cast structure of an alloy containing 12.53 per cent. Al, 1.59 per cent. Fe and 0.17 per cent. Mn. The predominating phase is one of beta, with possibly a trace of delta, as shown by the white spots. Such material is very brittle and not often met with in practice. This photograph is magnified 100 times. The photograph (Fig. 13) is of the last composition after forging and annealing at 650 deg. C. for ¼ hr. and air cooled, magnified 500 times. The structure shown is made up from beta and delta. Previous photographs of the beta phase have appeared of a dense dark colour. This has been due to over-etching and also to low magnification photography. In the present case the specimen has been lightly etched and the beta phase is acicular in appearance and highly twinned. Delta possesses extreme

fragility and in colour is yellow with slight bluish cast.

Fig. 14 is the last illustration showing the structure of the different phases, and represents the "as-cast" structure of an alloy containing 13.93 per cent. Al, 1.29 per cent. Fe and 0.51 per cent. Mn. When magnified 500 times, one sees beta ground mass and massive delta. This composition is so brittle that it can be easily crushed to powder with a small hammer. Delta, by the way, is possessed of considerable hardness.

This series of micro-photographs well illustrates the existing phases as the aluminium content rises. In alloys of low-aluminium content, maximum toughness and elongations up to 70 per cent. on 2 in. are given. In those of medium aluminium content there are strength and toughness combined, which, as the aluminium content rises, gives way to brittleness. The final conclusion is to make it a rule to keep the aluminium content for commercial work as far as possible between 5.0 and 9.8 per cent. All the previous micro-photographs were taken from sections etched with acidulated ferric chloride reagent, and it was particularly noticed that in etching them the acid attack was reduced with increase of aluminium content, and the primary crystal grains were similar in size. Furthermore, the "cored dentrites" common to the alpha alloys of below 6.6 per cent. aluminium disappeared in the presence of the alpha-beta phase. Fig. 15 shows micro-photographs of sand-cast sections containing 4.64 per cent. Al, 6.59 per cent. Al, and 10.39 per cent. Al respectively. The lower degree of etch attack on the alloy of highest aluminium content is clearly apparent, and a general observation on this point would lead one to think that the higher the aluminium content the better, from the standpoint of corrosion resistance. The "cored dentrites" inside the primary crystals of the alpha alloy are also in evidence, and it may be interesting to point out that these are very difficult to remove by any form of subsequent treatment. Any alloy which exhibits "cored dentrites," if forged, tends to produce a "banded" structure under the microscope. This was apparent in the micro-photographs shown earlier in the Paper representative of the alpha phase. Careful observation of the etched structure prior to microscopical examination is often of great value, and in the case of castings made from the simple aluminium bronzes, one is able to estimate the aluminium content present. So much for the more technical side of the aluminium-bronze group. There now remains the practical side of things and the problems of manufacture.

(To be continued.)

Induction Furnaces for Low-Frequency Three-Phase Currents.—In a thesis submitted to the Technische, Hochschule, Berlin, which is summarised in a recent issue of "Stahl und Eisen," M. Schwedler discusses the practical design and utility of low-frequency three-phase current induction furnaces which are fed directly from the mains. In an experimental furnace used by the author in a series of practical tests, the winding was similar to the stator winding of three-phase current motors and was also enclosed to reduce the magnetic resistance of the circuit. The crucible was surrounded by a copper coil through which cooling water is circulated to reduce the flow of heat from the melt to the winding and permit a correspondingly higher load on the winding. The furnace was 20 cm. high and 20 cm. in dia., with a conductivity of 80,000 Siemens per cm., the gap between the iron and melt being 1.8 cm. The performance of the furnace was found to be in good agreement with the theoretical values, as shown by a series of curves. From investigations with a variety of similar furnaces, the author concludes that these furnaces are as efficient as single-phase high-frequency electric furnaces provided the capacity exceeds 500 kg. The power consumption is, however, slightly lower.

Institute of British Foundrymen.

BIRMINGHAM COVENTRY AND WEST MIDLANDS BRANCH ANNUAL DINNER.

The annual dinner of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen was held on Saturday, January 28, at the Imperial Hotel, Birmingham, the President (Mr. J. G. Pearce) in the chair.

Proposing the toast of the "Institute of British Foundrymen," COLONEL J. BALDWIN WEBB, M.P. for the Wrekin Division of Shropshire, said he represented a division which was particularly interested in their industry, and which was in fact the cradle of the iron trade. Shropshire was the native county of two of the greatest men in the industry, namely Darby, who was the first man to adopt the smelting of iron on a large scale by means of coal and coke, and John Wilkinson, who was generally regarded as the father of the iron trade. He had great foresight even in casting his own coffin. The Institute was a combination of all those who were actively engaged in working in the improvement of industry. The favourable position of the iron and steel industry as compared with similar industries abroad was in some measure due to the Institute. In Europe production had declined at double the rate that it had in England during the last two or three years. He found figures recently referring to iron and steel production which showed that we were not only suffering from over-production, but before the War we were increasing our production at the rate of 6 per cent. per annum. Had that figure been maintained we should have now been producing something like twice the amount we are to-day. The Institute was actively engaged in the development of the industry in searching for new ideas and in trying to make the industry more self-reliant. The Birmingham Branch must have a varied membership because of its many interests in the foundry world, and the Branch was actually more representative than any other Branch. It was with considerable pride that they remembered that the Institute was founded in Birmingham.

The Race for Leadership in Steel Production.

MR. VICTOR STOBIE (President of the Institute), responding to the toast, said great advances had been made in the iron industry since the birth of the Institute. It was possible to look at the problem of over-production from another point of view. Were they not suffering, he asked, from under-consumption? It was a far worse thing to have insufficient work than to have workpeople doing more than was necessary. Production in iron and steel in this country was distinctly less than in any other country since 1926. At one time this country used to lead, but that lead was lost, first of all to the United States and afterwards to Germany. Germany then lost it to France. France, however, had to import coal for its iron and steel-making, whereas we were self-contained to that extent. Something like 70 to 100 papers were read before the Branches and at the annual conference of the Institute in a year, and those Papers were contributed by experts. The members included some of the finest metallurgical scientists, technicians and practical men, and for that reason the Institute should be supported and encouraged by everyone in the foundry industry. The advice of the Institute was being sought more and more and educational work took a very important place. National certificates came to the Institute to be countersigned from the Institution of Mechanical Engineers and the Board of Education, and Birmingham had sent more of these certificates than any other town. Something like eighteen or nineteen out of the 30 which had been sent in represented students who had passed with distinction. The Institute was doing a wonderful work very modestly, but whatever their accomplishments in the past their definite programme to-day showed a considerable advance on that.

Value of Technical Societies.

MR. TOM MAKEMSON, Secretary of the Institute, proposed the toast of the "Birmingham, Coventry and West Midlands Branch." He pointed out that although the Institute was founded in Birmingham, the first Branch started in Manchester. There were men, however, from Birmingham, such as Mr. Buchanan, Mr. Finch and Mr. Cook, who had played a tremendous part in the Institute's career. In looking through the Proceedings one was struck by the fact that the Branches had always endeavoured to keep their Papers up to date. The foundry industry had evolved very rapidly, very big strides having been made in the last quarter of a century. Every important change seemed to have been the subject of a Paper, and it was a moot point whether the development had caused the Paper or the Paper caused the development. To-day the activities had extended and included research in connection with the British Cast Iron Research Association. That work was most valuable to the whole of the members. The Association in fact was a most valuable ally among the societies with whom the Institute was working in conjunction. The Birmingham Branch, although it had 250 members, was not the largest Branch. It ought to be bigger, although one realised that the times were difficult, but whatever economies were made the contribution to a technical society and a research organisation was one of the last that ought to be made. It would be a very short-sighted policy for anyone to discontinue their membership. It savoured of the captain who threw his charts overboard to lighten his ship. The Institute was holding its own and probably more active than ever. Its membership was being maintained. In view of the work it had set out to do it required funds, and they could only be obtained through increased membership. Anything that Birmingham could do to make the Branch stronger would redound to the Institute as a whole and be of incalculable benefit to the technical side of the whole industry.

MR. J. G. PEARCE, responding to the toast, said Birmingham was a city to be proud of, and it contained some very historic foundries which were the cradles of the engineering industry. The city in fact had been the cradle of many movements that had migrated elsewhere. The Branch was more representative than any other, and it was safe to say that if the rest of the country went out of the foundry business the Birmingham area could deliver the goods as required all the time. They would in fact be very glad of the opportunity. Its diversity of interests, however, made programme building very difficult for the Birmingham Branch. The close connection of the British Cast Iron Research Association had been a source of gratification to him personally and to the Council of the Association. They all hoped that those good relations would long continue.

The toast "Our Guests" was proposed by MR. F. J. COOK (Past-President of the Institute), and responded to by MR. WALTER HIGGS (President of the Birmingham Rotary Club).

Classification of Rustless Steels.—In the course of a Paper read recently before the American Society for Steel Treating, MESSRS. E. R. JOHNSON and R. SERGESON described the manufacture of rustless steels and suggested a classification into four groups with varying carbon content: (1) Low-chrome alloys, 10 to 14 per cent. chromium; (2) medium-chrome alloys, 16 to 30 per cent. chromium; (3) chrome-nickel, 18 per cent. chromium, 8 per cent. nickel, and (4) complex chromium alloys with other alloy additions. These alloys are applicable for definite uses as follows: (A) Atmospheric corrosion (groups 1, 2 and 3); (B) immersion or liquid corrosion (groups 2 and 3); (C) scaling at high temperature (groups 2, 3 and 4).

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Phosphorus in Cast Iron.*

By W. West (Leyland Motors, Limited).

During the last two decades there has been a great revision of opinion among the founders of cast iron; at one time it was thought that pig-iron had hereditary properties, mostly bad, which were the cause of many wasters in the foundry. This opinion may not now be so prevalent, though there is still some little truth in the supposition. The physical characteristics of pig-irons are greatly influenced by variations in blast-furnace operations, and two pig-irons with identical compositions may still be radically different from each other in physical properties, even after a remelting process in the cupola. Foundrymen, however, are not looking for a millenium period of perfect pig-iron for perfect castings, but rather to obtain pig-iron of more or less constant composition and physical properties, and on this point the so-called refined irons fill the breach.

High Tests and Solidity.

In a great measure improvement in the properties of cast iron has come through a better understanding as to the influence of the various elements and compounds which contribute to its constitution. The use of steel additions to the mixtures for casting purposes was but a prelude to the great demand that exists to-day for special refined iron, "so called," because of the increased mechanical results and sounder castings obtained from the use of them. These two outstanding requirements of the foundryman for high mechanical tests and solidity in the cast iron are intimately locked up in its constitution and structure. Constitution is derived from the chemical nature of the different elements and compounds, and the relative proportions of them present. Structure is the size and arrangement of the constituents, and is largely governed by the rate of cooling, and secondly by the proportions of the respective constituents. If cast iron be considered for a moment in the light of a carbon-iron alloy, and assuming the other constituents usually present to exert no influence, it becomes evident that the proportion of carbon which can be taken into solution in iron at different temperatures is a factor of great importance.

It is definitely known with a degree of accuracy that iron takes up at its melting point 4.3 per cent. carbon, and because of its characteristic solidification point of 1,135 deg. C., is known as the carbon eutectic. The presence of more or less than this percentage of carbon has its corresponding effect upon the structure and the solidification point of the iron. The addition of other elements, such as silicon, manganese, phosphorus and sulphur, modifies the carbon percentage at which the eutectic is formed, and thereby the solidification point of the alloy. For example, in an ordinary iron alloy, the presence of 2 per cent. silicon and 1 per cent. phosphorus produces a eutectic composition when the carbon content is approximately 3.4 per cent. In addition to the effect of these other elements contained in the pig-iron, and their effect upon the ultimate structure, consideration must be given to the rate at which the liquid iron cools to the solid state. Among all the constituents of the composition of cast iron, carbon which exists in the free or graphitic condition predominates, but the degree to which it does so depends largely upon the amounts of the other constituents and the rate of cooling of the alloy.

Carbon Matrix.

Thus the development of the combined carbon matrix has been largely fostered of late years, and in the production of higher mechanical strength properties, a maximum of pearlite, or combined carbon eutectoid, in the structure, has proved highly successful, more especially where the total amount of carbon has been kept lower than usual. In the production of grey cast iron for strength and solidity, concentration of thought and control has been chiefly between the respective amounts of total carbon and silicon. It is common knowledge that this element, silicon, exercises an influence similar to that of the cooling rate, inasmuch, as the proportion of it present increases, so the properties of iron improve towards the point of maximum pearlitic structure or combined carbon eutectoid, after which, further additions cause a diminution in strength and an increase in openness or porosity, where all other factors are constant.

Effect of Silicon.

The obtaining, however, of a maximum pearlitic structure or combined carbon eutectoid, without a neutralising effect of large precipitated graphite flakes, demands a restriction of the amount of total carbon. The work of Hamasumi, Honda, Murakami, confirm that there does exist a range of silicon contents between 1.0 to 2.5 per cent., in which an increase of this element is followed by an increase in graphite, and such a diminution of carbon in this eutectoid, that the constitution remains graphite-pearlitic. The lower the total carbon, the greater is this range, and where this is reduced to approximately 2.4 per cent., and a high figure of silicon is chosen, say 3.0 to 3.5 per cent., it is possible to obtain such proportions that cooling speeds within certain limits have no effect upon the structure, and the mechanical properties are the same irrespective of wall thickness.

To talk of these possibilities in theory, despite their convincing character, is of quite a different order from the carrying of them out in practice. The multiplicity of other factors which enter in the problem of effecting improvements in strength and solidity of cast-iron castings cannot very well be ignored—items such as the size and disposition of runners through which the metal is poured, the nature of the material into which it is cast, the effect of superheat, etc., only point to the complexity of the problem, but at this juncture it is intended to keep them in mind only. This theoretical view, however, is of prime importance to the foundry industry, where increased strength properties are required. High strengths hitherto unknown have been and are now being produced from cupola melting by the use of so-called "refined irons," having lower total carbon contents than that produced direct from the blast furnace. The availability of these refined irons has made it possible for the general run of foundrymen, who have no special technical knowledge at their disposal, to control the relative proportions of the constituents in the cast iron used, to produce a shorter freezing range alloy, and thus overcome much of the porosity which is the commonest of foundry accompaniments.

Low-Carbon Irons.

It is not to be accepted, however, without question that the whole secret of the value of remelted irons is bound up with the lower total carbon contents they contain, nor yet with the refined grain of the graphitic carbon which unquestionably is of value, more particularly where higher strength is desired of the cast-iron mixture. This Paper is an attempt to show that with most "refined irons," so-called, there is invariably one other attendant factor which largely contributes to the successful results which have and are being obtained in the production of solidity in thick and uneven sections of castings. Most of these particular remelted irons have their origin in the form of higher carbon pig-iron, which element is reduced in the remelting process by the addition of an appreciable proportion of steel scrap, or the removal of some of it by oxidation, either by Bessemerising it or by oxidation in Siemens open-hearth practice. With the introduction on a commercial scale of the pulverised fuel furnace, unlimited scope is put into the hand of the remelted iron producer for the use of any kind of material whose chief constituent is iron. The outstanding feature, however, of most successful remelted irons is not the low total carbon content, but rather the low phosphorus percentage they contain.

As far back as the so-called semi-steel days, the great feature of the remelting mixture of steel and pig-iron was the low phosphorus content—not because it was specifically sought after and produced, but rather that it became a natural sequence of such additions of steel having low phosphorus contents. Taking a review of all the special irons which have appeared and in some cases disappeared, low phosphorus was an attendant factor. The fact still remains true with those remelted irons which have definite claims to no association with scrap of any sort, the basis of such product invariably is found to be a hematite iron.

The determination of the total shrinkage of cast iron due to liquid and solidification shrinkage has been the object of many researches. Smalley[1] carried out a series of experiments on grey cast iron by casting conically-shaped specimens to determine any relation between the volume changes taking place during solidification and the tendency to form a pipe. Longden[2] also employed cylinders and spheres fed and unfed in order to measure the degree of liquid shrinkage in grey cast iron. Schwartz and others have used various methods to the same end, and these have been carried out more on practical lines than as academic experiments.

Whilst many criticisms may be made of such methods of determination because the figures obtained may not actually represent true value, and also there is no differentiation between the shrinkage arising from liquid contraction and that due to contraction through solidification, the comparatice results have great usefulness in foundry practice. The results obtained by these research workers do not directly indicate any relation between the phosphorus content and total shrinkage of grey cast iron. Smalley indirectly mentions the effects of phosphorus, but this occurs more as an impression of personal opinion than a series of directed experiments to determine its influence.

Phosphorus and Casting Porosity.

To determine directly any relationship that may exist, tests were designed which would be as closely allied to foundry practice as it is possible to do. All moulds were made of dry sand, with one exception, and no sand cores were used, so that gas generation in the mould might be reduced in quantity to the lowest limit. Runners attached to the moulds were all of a standard size and pattern, and in all the foundry technique was meticulously watched to avoid any variable factor. The cast iron used for the experiments were built up from one common base, *i.e.*, a low phosphorus hematite, to which for sake of convenience ferro-phosphorus was added in predetermined amounts to give the phosphorus contents required. The temperatures of all mixtures were kept as near as possible around 1,300 deg. C., and tapped from a cupola into a hand shank, and then into the moulds.

(To be continued.)

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. E. Flower presiding.

[1] I.B.F., vol. XVI (1922-23), page 405.
[2] I.B.F., vol. XVIII (1924-25), page 573.

Foundry Costing.*

By Alex. Young, F.I.A.C. (Secretary, British Bath Company, Limited).

A reliable system of cost accounts is an essential unit in the organisation of the ironfoundry of to-day, and to be of any real assistance, the system must be sound and accurate, both in theory and in practice. The following remarks are intended primarily to apply to a light castings foundry, but the system could readily be adapted to any type of foundry. This is an essential point which must be considered when it is proposed to institute a costing system, namely, that the system adopted is a practicable proposition meeting the requirements of the particular foundry in question.

In the course of the following remarks, an endeavour will be made to view the whole matter in the light of the requirements of the proprietors or executive who it is assumed are responsible both for the manufacturing and marketing of the casting, and in so doing, to depart from the purely works accountant, or foundry management, point of view. In short, the ultimate goal will be to weld the frequently conflicting interests mentioned into one harmonious unit. In these enlightened times there is no need to emphasise the benefits accruing from the functions of the works, or cost accountant, but it is appreciated that many foundries are not in a position to employ a full-time official of this description. Any system, therefore, which might be outlined would not be of much assistance, unless it took care of this type of ironfounder.

As general foundry and cupola practice have progressed very considerably within recent years, there has been as a result of this progress a marked advance in the appreciation of the necessity to compile useful and accurate statistics. In many cases, unfortunately, the progress has been decidedly slow, and has met with considerable opposition from the ironfounders of the old school, and the accountant (if any) has had a particularly hard road to travel. Too many ironfounders are satisfied with a glorified book-keeper when they really could, with profit to themselves, employ a specialist suited to their particular business.

In the early days of industrial development, a ledger system of book-keeping, which was known as "single entry," was quite sufficient to meet the needs of the times, but when more reliable and accurate information was required as to trading and financial results, a more complete and accurate system became necessary. This is not intended to be a Paper on the disadvantages of "single entry" book-keeping as compared with "double entry," and in a word the "single entry" idea could be defined as simply a record of personal transactions which had been collected in the ledger, but which only disclosed the intromissions and balances on personal accounts. To attempt to make up a profit and loss account and balance-sheet on this system is a feat which is almost without hope of accomplishment with accuracy, as the records are in themselves incomplete. On the other hand, "double entry" book-keeping functions in such a way that a complete statement of affairs can be extracted from the financial books at any given date, supplemented, of course, by the usual stock-taking records, etc.

Some of the costing systems which have been known to exist might well be likened to the "single entry" system of book-keeping as compared with the "double entry" system. In short, they are merely extracts from records and not in any way complete as a system. Most ironfoundry organisations are large enough to require a complete system of accountancy in order to ensure a proper presentation of the accounts to the Inland Revenue, and while the same business might not be large enough to carry the additional cost of a works accountant, it should be possible to arrange a system of cost accounts which would function as part of the general accountancy system.

It is proposed, therefore, to outline a system of cost accounts which could easily be operated by an ironfounder from his existing records as required for the financial accounts, supplemented, of course, by a few details of foundry and manufacturing statistics, and at this stage it might be well to submit a theoretical definition of the science of costing.

Cost Accounts.

"Cost accounts" are those accounts which contain any systematic record of expenditure incurred in production, output, construction or services rendered. The installation of an efficient system of costing requires a close study of the conditions, routine and organisation of the foundry to which it is to be applied, including its departmental and inter-departmental methods and relations. To be of practical utility there must not only be regularity in the preparation and critical examination of records by those responsible, but the information must be presented in suitable form and detail.

Costing primarily concerns itself with the proper records of existing facts from which any defects or improvements may be deduced, or in other words, in order to reduce cost, which, after all, is the end which every manufacturer who institutes a costing system hopes to achieve, the existing cost must first be determined. The first consideration in setting up a system of cost accounts must be the arrangement of the various items of expense which unite to form the cost of producing any article in suitable groups. For a foundry costing system, and in fact, for any manufacturing business, the grouping under the following heads is almost inevitable: (1) Direct materials, (2) direct wages and (3) oncost.

Direct materials includes the cost of all materials which can be specifically allocated to any particular job or casting, and this definition also applies to "direct wages." Oncost includes wages and materials, which cannot be allocated in this way, and all overhead charges. From the definition of oncost it will be noted that this includes a wide variety of charges, or items of expense which cannot be specifically allocated to any particular job or casting, and the difficulty in connection with oncost is not in arriving at the total amount of expenses it is designed to cover but in knowing how to allocate it to the productive department, or the article produced, to ensure that the amount apportioned to each is the nearest approach to what has been actually incurred.

Distribution of Oncost.

The distribution of "oncost" is the most important and interesting phase of cost accounting, and consequently the best method of accomplishing this is probably more in dispute than any other factor. As most foundries are a convenient grouping together of the various departments or processes, it should be possible to allocate a very large proportion of the "oncost" charges to particular departments, or processes, which might be described as "shops." This allocation is essential if an accurate cost of the finished casting is to be ascertained at each stage of its manufacture, and, for the purpose of re-charging defective workmanship, this allocation will be appreciated later. The "oncost" which cannot be allocated to any particular department or process would be collected in an account named "general oncost" and would include items of "office oncost" and in many cases selling and distributing expenses.

Having regard to the seasonal trade carried on by many foundries, it is advisable to arrange the costing system on a yearly basis, and in establishing oncost it is necessary to ascertain the amount of expenses which have been incurred in the period under review and to apply such amount in relation to some direct basis, such as the number of castings produced, tonnage of castings produced, direct wages, or any other method which might be selected as being the most suitable basis of oncost application for the particular foundry in question.

The next step is to select the most suitable basis on which to express the "oncost." In the search for the most suitable basis, care should be taken to select the item which is the most stable of the items comprising the cost of producing the castings. Experience has proved in the majority of cases that "direct wages" is the most satisfactory basis, as it is the most constant and regular of the alternative methods. By reason of the wide variety of castings produced in most foundries and the vast difference in many cases of cost of the labour, etc., entailed in the manufacture, it is obvious that oncost cannot be allocated on a unit basis, and as the weight of a casting has frequently no relation to the actual cost of manufacture, the tonnage basis cannot be employed.

It must be admitted that many students of foundry costing consider that the best method, by which to express "oncost" is in relation to the weight of castings produced. This procedure may be perfectly sound in the case of a foundry producing only one type of casting, where there is no difficulty in securing an accurate statement of the weight of total production as well as accurate weights for each casting produced, but in many branches of ironfounding the weight of the finished article differs widely from the actual weight of cast metal used in its manufacture or construction. For example, in the case of a cooking range, there is a considerable increase in weight by reason of the introduction of fitted parts, including firebricks, boiler, knobs, sheet iron, etc. Another example which could be taken to illustrate this difficulty is the case of several castings of equal weight, but of widely varying character. One might be a heavy manhole or drain cover, a second might be a casting with a highly polished or porcelain enamelled finished and yet a third might be a casting requiring very intricate cores. Although the weight is the same in each case, it would be unfair to load the cost of each with an equal proportion of "oncost."

Further, in many light-castings foundries it would be a matter of extreme difficulty to secure accurate weights of each casting produced, and the danger of loading an inaccurate weight with the "oncost" lies in the fact that the original inaccuracy would be increased two or three fold.

On the other hand, the amount of "direct wages" is the one item comprising the cost on which there need be no risk of inaccuracy. If a piecework system is operated, it will be a simple matter to ascertain the cost of "direct wages" required to produce any casting. Even where a piecework system is not operated there should be no difficulty in determining the "direct wages" from records of previous similar work.

Whilst due deference must be paid to the experience and opinions of the ironfounders who express the "oncost" as a rate per cwt. of finished castings, there is no doubt that in the majority of foundries the use of "direct wages" as the basis will be found to be more suitable as a means to ensure the most accurate allocation of "oncost." In certain cases it has been found advisable to operate the two methods side by side, and this practice might be useful or even necessary by reason of the variety in the nature of the castings produced. For the present purposes, having regard to the greater

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utility for the majority, "direct wages" will be used as the basis. The "oncost," therefore, should be presented as a percentage of "direct wages."

Having defined and examined the basis of assessing "oncost," the next step in the system is to prepare the details from which to extract: (1) "Direct wages" earned in each shop; and (2) total "indirect charges" or "oncost" incurred for each shop.

Allocation of Wages.

No ironfounder should have any difficulty in arranging his wages book in such a way as to present each week a complete analysis of the wages, as to the "direct" and "indirect" wages spent in each department. Loose leaf books are to be recommended, and names on the wages sheets should be arranged in sections to simplify the work of extracting the particulars for the weekly analysis. The details of the weekly analysis should be posted weekly in order to disclose at the end of the costing period the total "direct" and "indirect" wages spent in each department.

Allocation of Materials.

In order to arrange for the proper allocation of materials, the "purchase day book" should be abstracted to disclose at the end of each month the total value of materials purchased for each department. To simplify the monthly abstract, the "purchase day book" should be ruled in columnar fashion with a column for each shop. If it is not practicable to have a column for the direct materials and indirect materials for each shop, it should be a simple matter to group together in certain cases and analyse the necessary columns, but in any event, the important information to secure from the "purchase day book" is the total of "indirect materials" applicable to each department for the period. It is appreciated that certain stores are common to all departments or shops, and that proper allocation is impossible in the "purchase day book." These can be taken care of in an account named "general stores," which would be operated by a requisition system and allocated accordingly to the respective departments.

The importance of correct and accurate stores records for costing purposes cannot be too strongly emphasised, and this might well form the subject of a separate Paper. It will be necessary on the present occasion to confine the remarks to the essentials, as it is recognised that the details might easily be adapted to suit individual requirements. There should be in use an accurate and reliable record of all stores received for manufacturing and other purposes, and of their issue from time to time, together with a satisfactory check on the stores in hand at any given period. By this system the cost accountant is in a position to secure a statement from the store keeper of the issues during any period, and this statement would be used to make the proper allocations to the various departments. It would be of great assistance for checking purposes at stocktaking, and also to ensure that adequate supplies of the stores are on hand.

Stores.

It should be carefully noted that the prices of all purchased materials and stores should include free delivery at the works, and it might be well to allow in the cost accounts for breakage, etc., in stores.

Rent.

In many cases there has been a tendency to ignore rent when compiling cost accounts, but in these times it is obvious that this is an item which cannot be overlooked with impunity. In the case of an ironfounder who rents his premises, there will be no difficulty about the amount which should be included in the cost accounts for this item, but, on the other hand, the manufacturer who owns his premises and the land on which they are built, is in a different position. In the latter case the figure used should be the "net schedule A assessment." Whichever figure is used, the allocation of rent to the various shops still presents some difficulty. A common practice is to allocate the amount of rent to the various departments in proportion to the actual floor space occupied. While this practice might be quite useful in cases where there is nothing in the way of specialised plant, or production, it is obvious that in the majority of cases it will not answer. It is a commonplace that the assessable value of a factory is more or less based on the value of the buildings and the plant installed in each department, and it should be possible to secure an approximate allocation based on the figures of the assessors, which should be used as far as possible for the allocation of rent to the various shops.

Rates and Taxes.

For local rates the allocation should be along the same lines as for the rent, and, in point of fact, rent, rates and taxes might well form a single allocation. Income tax should not be provided for in cost accounts, as this is a charge on profits and cannot be treated as a manufacturing cost.

Depreciation and Maintenance of Buildings.

Where the manufacturer owns his premises consideration should be given to the depreciation of buildings. This could be arranged by writing off an equal amount each year, during the occupancy of the premises, based on the estimated life of the buildings. Another method which could be employed would be to write down yearly, a fixed percentage off the depreciated value. The actual cost of repairs and maintenance of the buildings should be debited in the "oncost" of each department. In the case of repairs by outside contractors, the actual figures would, of course, be disclosed in the purchase day-book, and repairs executed by the manufacturers's own staff should be charged against the "oncost" of the various shops. In cases where several departments are housed in one building under the same roof, the allocation of the maintenance charges on buildings could be allocated along somewhat similar lines to the allocation of rent.

It is needless to emphasise that the Inland Revenue authorities do not allow both depreciation and maintenance of buildings, as charges against profits for the purpose of the computation of the amount of liability for income tax. It is therefore well to consider whether for the purposes of costing the two charges are necessary. Provided the "net schedule A assessment" is taken, together with the rates, taxes, insurances, etc., and all the "repairs and maintenance" charges are properly debited, there should be no need to charge depreciation of buildings in the "oncost."

Depreciation of Plant.

The depreciation of plant is a matter which calls for very careful consideration, and the manufacturer should be careful that the value of the plant is written down each year, to a figure which is commensurate with a reasonable estimate of the life of the plant, based on the purchase price. Theoretically, for the purposes of income tax, depreciation is not allowed as a charge against profits, but the inspectors of taxes have instructions to make certain allowances towards "wear and tear of machinery and plant." In many cases, unfortunately, the allowance is insufficient to permit of the plant being written down to scrap value when it ceases to function as a useful unit, although it is possible to negotiate an allowance for obsolescence. In this event it is much more satisfactory to make proper provision in the "oncost" for the "depreciation of plant," based on an expert estimate of the life of the plant, in spite of a temptation to provide only for the allowance made by the inspector. As the various items of plant would be conveniently grouped under the different departments, there should be no difficulty in the allocation of the total depreciation.

Repairs and Renewals of Plant and Machinery.

At the outset it would be well to emphasise that only items which are charges against revenue should be provided for in the "oncost." Great care must be taken that no item of "capital expense" is allowed to appear inadvertently. The cost of spare parts of machinery and plant will be disclosed in the "purchase day-book" and also the cost of "repairs and renewals" carried out by outside contractors. There will be no difficulty in the allocation of these items from the abstract of the "purchase day-book." Provision must be made, however, for the recovery in the "oncost" and the correct allocation of the cost of maintaining the plant and machinery, together with repairs and renewals which have been executed by the foundry-maintenance squad.

To arrange for this, the "maintenance department" should be treated as a separate shop. The "oncost" should be determined and expressed in a similar manner to that employed for the other shops, but as the total cost of repairs and renewals of machinery and plant must be recovered against the producing departments, the procedure is along somewhat different lines. The main items of repairs and renewals, will, as has already been stated, be allocated from the "purchase day-book" abstract and many smaller items of stores will be recovered on the job cards of the men employed in the maintenance department. These smaller items can also be debited direct to the various departments concerned. There remains, however, a variety of smaller stores which cannot possibly be allocated to any particular job or department, and which can only be taken care of in the "oncost" of the maintenance department.

The "oncost" of this department would also include the usual items for indirect wages, rent, etc., and should be expressed as a percentage of the "direct wages."

The allocation to the production departments would be determined by the abstract of the job or time cards, the debit being "wages and materials" plus "oncost," and in this manner the total cost of "maintenance, repairs and renewals," etc., would be liquidated by transfer to the productive departments. The foregoing is simply an outline of the general procedure as it will be appreciated that in some cases a much finer or more exacting allocation is advisable. For example, in the case where the repair shop is equipped with machines with widely different running costs, it would obviously be necessary to secure accurate information and allocate accordingly. The essential, however, is to ensure that the total cost of running this department is recovered in the oncost of the productive units.

Power.

This item should be treated as a separate department and allocated according to consumption. The procedure would be the same, whether the power is generated or purchased. It is obvious that no set rule can be laid down with regard to the allocation of power, as in the first place a very wide variety of power is employed in iron foundries. While the majority of modern foundries are electrified, there are still a few where steam is found to be quite economical. A fairly safe rule to work to in the allocation of power, however, is to allocate the total cost of the power for the period on a percentage basis, according to the quantity consumed by the various departments. The estimate of the percentage might be more or less arbitrary, but so long as the total cost of the power is recovered over the various departments, the allocation will be perfectly sound for costing purposes. On the other hand, where a foundry is fully

equipped with the most modern electrical plant, it should be possible to have a fairly accurate estimate of the cost of power which should be allocated to each department. In many cases separate meters could be installed, but, in any event, it is always possible to use an apparatus to ascertain the exact power cost of each machine, provided the total power account justifies the expense of this apparatus.

Lighting.

This cost should be dealt with in a similar manner to the power account.

Breakage and Damage in Manufacture.

The loss represented by wasters, or by breakage in the process of manufacture, should be charged in the "oncost" of the department in which the breakage has taken place. The amount so debited should include the cost of manufacture up to the time of the breakage and should provide for the recovery of all "direct wages" and "shops oncost" after allowing for the salvage value of the casting. The manner of recovering the cost of breakages and wasters may be adjusted to suit individual requirements, but the essential point is to provide for the recovery in the "oncost" of the production departments of the total cost of breakages, etc.

Moulding Boxes.

The correct method of dealing with this item is comparatively simple where the moulding boxes are all purchased from an outside source, as it simply means that the cost of repairs and maintenance, together with the depreciation, would be a charge on the "moulding-shop oncost." On the other hand, where it is the practice of the foundry department to cast and fit their own moulding boxes, the actual cost in wages, materials, etc., for new boxes should be capitalised. The replacement, maintenance and depreciation, would, of course, be charged in the same manner as described for the bought-in boxes.

Pattern-Shop Oncost.

Where the foundry pattern shop is solely occupied in the replacement and maintenance of the running patterns there is no difficulty in dealing with this department, as the total cost of running the department would simply be a charge on the moulding shop. It could be included as an item in the "moulding-shop oncost," or it could be shown separately as a percentage on the "direct moulding wages." Frequently, however, the ironfounder is required to prepare patterns for a special client, and where there is any considerable volume of this class of work it must be adequately dealt with in the costing system. The time and materials spent on new patterns, or on patterns for special orders, should be kept distinctly separate, and either capitalised or charged direct to the special job, as the case demands. It will be appreciated that the procedure is bound to vary according to the amount and variety of patternmaking involved, and due regard must be given to the replacing of patterns which become obsolete by reason of changing fashions. The important point which must not be lost sight of is that only the cost of maintaining and repairing the running patterns should be a charge against "oncost."

Warehousing, Loading and Despatch.

These charges are frequently expressed as an item in "general oncost," but they could also be dealt with separately and based on the tonnage of castings despatched, provided the class of goods handled warrants this method of allocation. The correct method of dealing with these items is bound to vary to suit individual requirements.

Works Section of General Oncost.

While provision is made in the foregoing for the recovery in the various shops' oncost of the main items of "works oncost," it must be admitted that there still remain items which are difficult to allocate in this way, and these can best be disposed of by recovery in the general oncost under the heading of "works section." This section might include such items as timekeeper, storekeeper and night watchman's wages, cost of running works canteen, general labourers, etc.

General Oncost.

Office Section.—This would include the office proportion of fire insurance, rent, water, office expenses (telephones, stationery, etc.), and salaries of office staff and management.

Sales Section.—This would include travellers' salaries and agents' commission, advertising and cost of advertising literature, etc.

The total of the "general oncost" should be expressed as a percentage of the "total direct wages." It is frequently useful for the purposes of comparison to express each of the three sections of general "oncost" in relation to "direct wages," but this is not essential.

Cupola Costs.

The correct method of dealing with cupola costs is probably the subject of more controversy than any other phase of foundry costing. A cupola costing system which is capable of general application should be aimed at, and the first consideration must be to ascertain the melting cost. The output of "good castings" should form the basis on which to express this cost, and it is only necessary to deal with the actual items which constitute the cost of bringing down the metal. Under this heading would appear wages and all the usual overheads, rent and rates, depreciation, etc., plus maintenance charges, power, coke, limestone, stores, etc. The total of these various items, which can readily be obtained from the abstracts, etc., already described, represents the cost of running the cupola for the period, which should be expressed in relation to the tonnage of "good castings" produced.

To arrive at the cost of the metal itself, a very simple method would be to take the average price of the pig-iron and the outside scrap purchased for the corresponding period. The system of pricing the metal may, however, be adjusted to suit individual requirements and market fluctuations, so long as the average market, or purchase price of the pig-iron and outside scrap, is aimed at.

Having determined the cost of melting and the price of the metal, the next step is to ascertain the loss of metal in melting. This is simply a question of comparing the consumption of purchased metal with the output of good castings, the difference representing the melting loss. For estimating purposes all the necessary information is available, thus, (1) melting cost; (2) price of metal; and (3) melting loss.

Cupola statistics would be incomplete without some information as to the relation of the output of good castings to the total quantity of iron melted. By a very careful examination of the results disclosed by this information the ironfounder is in a position to judge whether his cupola practice is sound or otherwise. Sound cupola practice, however, cannot be judged on an arbitrary percentage of good castings to metal melted, by reason of the fact that the ratio of good castings to iron melted is bound to fluctuate in sympathy with the type of casting produced, and in one case 60 per cent. might be agreed as an excellent result requiring the most efficient cupola practice, while in another 70 per cent. might be ranked as representing the essence of inefficiency at the cupola. For example, where the gates and headers are negligible in comparison with the finished weight of the casting, a high ratio is possible, provided there is sound cupola practice and the proportion of wasters is also low. On the other hand, excessive wasters, heavy gates and headers and bad cupola practice, are all contributory causes to a low ratio of good castings to "metal in the ladle."

It will be appreciated that the information disclosed by cupola statistics calls for the most critical examination by the executive as well as by the accountant, having regard to the light thrown on results and melting cost. In certain jobbing foundries where there is great variation in the proportion of metal required for headers, etc., and where it is necessary to use different grades of metal from the same cupola, the "cost of metal in the ladle" might be a very useful figure for estimating purposes, but this method of estimating should only be used where the information available as to the weight of molten metal required to complete a casting is both accurate and reliable. It must be admitted, however, that the number of foundries where such a practice could be operated successfully must be so meagre as to be almost unworthy of consideration—the margin of possible error and inaccuracy being much too high. In the majority of general light ironfoundries, it will be found much safer to base the metal costs on the output of good castings.

Establishing a System.

Having considered the principles involved in the application of the costing system to a light castings foundry, the next procedure is to indicate the steps in correct sequence towards establishing a system. These are as follow:—Allocation of (1) rent; (2) rates and taxes; (3) insurance; (4) depreciation or maintenance of buildings; (5) depreciation of plant; (6) power account; (7) lighting account; and (8) water account; (9) debit the various departmental "oncost" accounts as detailed in the abstract of the "purchase day book"; (10) post the details from the abstract of the wages book, detailing both direct and indirect; (11) allocation of general stores; (12) allocation of repairs and renewals and maintenance by own staff; (13) debit cost of breakages; and (14) prepare statement of "general oncost."

At this stage, the postings on the cost ledger are complete for the period and the next step is to work out the "oncost" percentages. For estimating purposes all the necessary data as to "cost of melting," "loss in melting," "shops oncost" and "general oncost" are available, and after having ascertained the "cost of direct wages" and "direct materials," it is possible to make up an accurate estimate of the cost of any casting produced by the foundry in which the system is operated.

Reconciliation with Financial Accounts.

In the introductory remarks, it was stated that an endeavour would be made to outline a system which would function in conjunction with the "financial accounts," and it might be well in conclusion to review the position in the light of that statement. The only subsidiary books which have required special treatment for the system described are the purchase day book and the cost ledger. As the purchase day book and the wages book would require to be written up in any event for the financial accounts, the small matter of the special abstracts for costing purposes should not present insuperable difficulties. All the other data required forms part of the vital statistics of any well regulated foundry, so that the necessary subsidiary work required to prepare the entries for the cost ledger cannot be said to be excessive.

Provided a foundry is fully occupied with the production of a very limited range of goods, it should be possible to cost the products so closely that the estimated profit on each item when multiplied by the total production should be reconciled to the balance disclosed in the "profit and loss account." This might apply to a factory operating on mass production lines. It is recognised that comparatively few concerns are capable of this fine distinction of costing, as the production of the majority of foundries covers a very wide range of goods, involving the

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use of almost innumerable patterns. Even in a foundry which tackles the widest possible range of goods, it is possible, however, to reconcile the "cost accounts" with the "financial accounts." This can be accomplished by abstracting from the accounts of the various departments in the cost ledger all the debits for "direct wages" and "oncost." Against this total take the total debits in the "trading" and "profit and loss accounts," after making the necessary adjustments for items not chargeable to cost accounts, for example, "cash discount and interest charges," reserves, etc., and the "direct materials" not charged in "departmental oncosts." The totals of the cost ledger figures and the adjusted "trading" and "profit and loss" figures should agree. Further adjustment may be necessary to meet individual requirements, but the particular value of the system described lies in the fact that it is a complete system, capable of reconciliation with the "financial accounts" of any foundry where it is applied faithfully and accurately.

When this comparison is made the ironfounder is confident that all the costs of manufacture are taken care of in the cost accounts, and he has all the necessary data for the following purposes: (1) To compile historical records of the cost of producing the various goods manufactured during the period under review; (2) by using these records, after allowing for market fluctuations in the prices of materials, wages, etc., he is in a position to tender for fresh work and when necessary he knows just how far he may cut the price, and (3) to compare and examine the cost of producing the goods in the various departments in order to discover weak spots in the organisation.

As a result of these disclosures improvements in methods of manufacture may be introduced and economies effected, thus attaining a higher degree of efficiency, which would again be reflected in reduced costs of manufacture.

Russian Iron and Steel Industry.

According to official Soviet sources, the production of steel ingots and castings in Russia amounted to 4,878,300 tons in the first ten months of 1932, which was 11 per cent. more than in the corresponding period of 1931. For the same period, the output of pig-iron is placed at 5,122,700 tons, or 28.3 per cent. more than in the corresponding period of 1931, while the production of rolled steel was 3,506,100 tons, an increase of 10.6 per cent. The Soviet authorities had planned to increase the output of steel ingots from 5,350,000 tons in 1931 to 9,450,000 tons in 1932, and of pig-iron from 5,000,000 tons in 1931 to 9,000,000 tons in 1932.

The first two blooming mills to be built by the Soviet were installed at the Makayevka and Kamenskoye steel plants. In addition, four new blooming mills were set up, respectively, at the Magnitogorsk, Stalinsk, Noginsk and Zlatoust properties. The Hagnitogorsk blooming mill is said to have a capacity of 900,000 metric tons a year. Two additional mills of similar size are to be installed. A number of rolling mills were built, and at the Stalinsk plant a 650,000-ton rail mill was scheduled to start production during the last quarter. Construction of the first vanadium plant in the Soviet Union was begun at Kerch in August.

During the first nine months imports of iron and steel amounted to 608,720 metric tons, as compared with 846,487 metric tons in the corresponding period of 1931. Sheets, amounting to approximately 240,000 metric tons, were the principal item brought in. Exports were negligible. In 1932 Russia exported about half of the amount of manganese ore shipped in 1931. According to figures for the first nine months, 297,695 tons were shipped, compared with 552,397 tons in the first three quarters of 1931 (741,701 tons for all 1931 and 641,978 during 1930).

Production in Newcastle of a new aluminium alloy is expected to start shortly. Mr. H. J. Garrard, the patentee, is at present negotiating for premises and works.

The Institute of Metals.

PAPERS FOR ANNUAL GENERAL MEETING, MARCH 8 AND 9, 1933.

The following Papers will be presented at the Annual General Meeting of the Institute of Metals, to be held at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, on March 8 and 9, 1933:—

"The Distribution of Porosity in Copper Ingots," by N. P. Allen, M.Met.

"The Equilibrium of the Reaction between Steam and Molten Copper," by N. P. Allen, M.Met., and T. Hewitt, M.Sc.

"An Investigation of the Effects of Hydrogen and Oxygen on the Unsoundness of the Copper-Nickel Alloys," by N. P. Allen, M.Met., and A. C. Street, B.Sc.

"An X-Ray Investigation of the Copper-Aluminium Alloys," by A. J. Bradley, M.Sc., Ph.D., and Phyllis Jones, Ph.D.

"Graphitic Silicon: Heat-Treatment and the Electrical Conductivity of Aluminium," by L. H. Callendar, Ph.D.

"The Physical Properties of Zinc at Various Stages of Cold-Rolling," by R. Chadwick, B.A.

"The Application of the Diamond-Pyramid Indentation Test to Copper and Copper-Rich Alloys in the Form of Thin Strip," by Maurice Cook, M.Sc., Ph.D., and E. C. Larke.

"The Fatigue-Resisting Properties of Light Aluminium Alloys at Elevated Temperatures," by J. W. Cuthbertson, M.Sc.

"The Electrical Conductivity of Aluminium Wire," by A. J. Field, M.C., B.Sc., and J. H. Dickin, B.Sc.

"Note on the Influence of Volatile Chlorides on Magnesium and on Copper," by J. D. Grogan, B.A., and T. H. Schofield, M.Sc.

"The Interpretation of the Tensile Test, with Special Reference to Lead Alloys," by Prof. B. P. Haigh, M.B.E., D.Sc., and B. Jones.

"Some Effects of the Addition of Tellurium to Lead," by W. Singleton and B. Jones.

"Experiments on the Effects of Variations in Mould and Pouring Temperatures on the Macro- and Micro-Structures of Some Low Melting-Point Metals and Alloys," by Frances D. Weaver, B.Sc. (Mrs. Harold Heywood).

Solubility of Hydrogen in Metals and Alloys.—In a recent issue of "Archiv für das Eisenhüttenwesen" for November, L. Luckemeyer-Hasse and H. Schenck gave particulars of an investigation of the solubility of hydrogen in pure iron, chromium, nickel, alloys of these elements with iron and in a somewhat impure manganese at temperatures up to 1,200 deg. C., and in pure iron also up to 1,500 deg. C. At 1,200 deg. C. the solubility, in cub. cm. (at 0 deg. C. and 760 mm.) per 100 grms. of metal varied from 5.5 for chromium to 13.1 for nickel, being 7.5 for iron. At 1,400 deg. C. the hydrogen in solution in γ-iron amounted to 9.4 cub. cm. but at 1,410 deg. C. an evolution of hydrogen commenced which was complete at 1,430 deg. C. About 3 cub. cm. of hydrogen were given up in changing from γ-iron to δ-iron, about 32 per cent. of that in solution at 1,400 deg. C. A similar reduction in solubility occurred at 910 deg. C at the γ-α transition point, the amount of hydrogen dissolved in the γ-iron, 4.7 cub. cm., being reduced by 1.8 cub. cm. Nickel throughout increased the solubility of hydrogen in the alloys examined. Chromium reduced the solubility for alloys with α-lattice, whilst in the case of alloys with 5 to 15 per cent. Cr in the γ-range the solubility was higher than that in pure γ-iron. The sudden change in the capacity for absorbing hydrogen was brought into relation with the arrangement of the atoms in the lattice. In the case of manganese the solubility changed with each modification. The effect of absorbed hydrogen on the impact strength and hardness was investigated by quenching specimens of Armco iron from different temperatures, after heating them *in vacuo* and in hydrogen. These tests showed a considerable reduction in the impact strength, but no effect on the Brinell hardness, due to absorption of hydrogen.

The Institute of British Foundrymen.

INSTITUTE ELECTS NEW MEMBERS.

At a General Council meeting, held at the North British Station Hotel, Edinburgh, on January 21, 1933, the following were elected to its various grades of membership.

As Subscribing Firms.

I.C.I. (Alkali), Limited, Winnington, Northwich (represented by N. L. Evans, B.Sc., A.I.C., research metallurgist); J. Parish & Company, 40, Pelham Road, Gravesend (represented by R. W. Talbot, partner).

As Members.

A. Birchall, brass foundry director, Peglers, Limited, Doncaster; A. Blayden, managing director, Walker Castings, Limited, Sheffield; J. W. Lucas, malleable ironfounder, E. Lucas & Son, Limited, Dronfield; W. H. Pycroft, foundry manager, Qualcast, Limited, Derby; J. McL. Renwick, director of foundry plant manufacturers, Universal System of Machine Moulding & Machinery, Limited; F. C. Smith, foundry superintendent, Davy Brothers, Sheffield; R. Spriggs, manager, conveyor department, H. Morris, Limited, Loughborough; E. C. S. Greaves, representative, General Refractories, Limited, Sheffield; A. Turner, managing director, Foundry & Engineering Company, Limited, West Bromwich.

As Associate Members.

J. McG. Craig, foreman iron moulder, Cruikshank & Company, Denny; J. H. Dolphin, metallurgist, Dobson & Barlow, Limited, Bolton; D. Fulton, engineer, D. Fulton, 23, Bellgrove Street, Glasgow; R. Gillespie, assistant foreman, Cruikshank & Company, Denny; E. D. Gratwick, foundry engineer, Callender's Foundry, Willenhall; A. E. Harrop, foundry foreman, J. Bolding & Sons, London, W.1; C. W. Hawkins, manager's assistant, Cannon Iron Foundries, Limited, Deepfields; J. Herd, patternmaker, Cruikshank & Company, Denny; J. Holmes, iron moulder, Planet Foundry Company, Guide Bridge; H. Horrocks, rate fixer, C. Walmsley & Company, Bury; H. W. Keeble, works metallurgist and chemist, Craven Brothers, Reddish; D. W. H. Kirkaldy, steelworks pupil, English Steel Corporation, Limited; W. Martin, foreman patternmaker, Bergius Company, Limited, Glasgow; J. Mercer, foreman iron-moulder, Cruikshank & Company, Denny; J. Nicholson, foreman patternmaker, Cruikshank & Company, Denny; R. O. Patterson, foundry foreman, Sheepbridge Stokes Centrifugal Castings, Chesterfield; C. Rowley, chemist, B.C.I.R.A., Birmingham; C. Redfern, patternmaker, Craven Brothers, Stockport; H. Reeve, foundry foreman, S. Russell & Sons, Leicester; E. Roberts, assistant foreman moulder, Craven Brothers, Stockport; F. Squires, assistant foreman moulder, Wigglesworth & Company, Shipley; W. Stafford, foreman patternmaker, Craven Brothers, Stockport; J. T. Wharmby, brass moulder, E. Yates & Sons, New Mills; O. G. Wilson, assistant metallurgist, S. Russell & Sons, Limited, Leicester; F. A. Woolley, metallurgical chemist.

Associate Members.

H. Heywood, foundry underforeman, Asa Lees & Company, Oldham; A. Marshall, patternmaker, T. White & Sons, Paisley, and M. Spence, foreman brass moulder, Blairs, Limited, Glasgow.

As Associates.

P. C. Booth, apprentice in foundry work and metallurgy, B.C.I.R.A.; T. Burns, moulder, Tweedales & Smalley, Limited, Rochdale; A. Harper, iron moulder, Tweedales & Smalley, Limited, Rochdale; F. Horritt, iron moulder, Tweedales & Smalley, Limited, Rochdale, and A. J. Reid, patternmaker, Craven Bros., Stockport.

Notes on Some Common Defects in Steel Castings.*

By C. Howell Kain.

Introduction.

In the past the subjects connected with the production of steel castings have been discussed on very hackneyed lines, and at the present time it is difficult to finance research on which to found a new method of attacking the matter. An attempt has been made to present these problems in as new a light as is possible in view of the obstacle.

In these days of metallurgical enlightenment very few, if any, steel founders will acknowledge the slightest difficulty in meeting buyers' and inspectors' specifications for mechanical properties in steel. The writer least of all. Indeed, with the technical knowledge and ability now available, together with plentiful supplies of high-quality raw materials to be had at very low prices, there is no excuse for failing to meet modern inspection requirements. Failures do occur occasionally, but a feeling that the honour of the firm and one's personal prestige as a metallurgist are at stake always prevents any free discussion of this aspect of foundry practice when the matter is raised in a purely metallurgical Paper. Few founders, however, hesitate to air their views at great length upon what they are pleased to call "defects." These are such things as draws or blowholes, though it is difficult to understand why mechanical failure to meet the specification should not also be termed a defect.

Founders have all, at various times, told the world what they think of inspectors as a class, and have dealt feelingly with the ancestry of the particular gentlemen who call to pass judgment on their castings, so it is proposed to confine these remarks to a consideration of the three defects most commonly encountered in steel castings and to a few suggestions for their reduction or elimination.

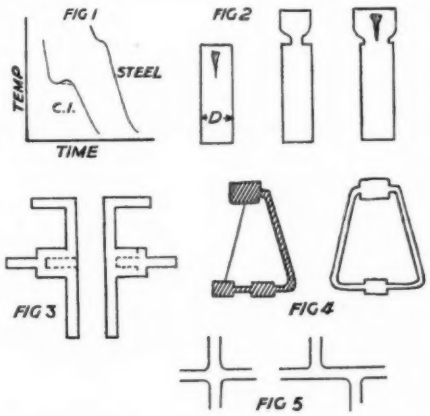
Types of Defect.

The greatest trials of a steel founder's life are caused by the three common defects, cracks, draws and gas-holes. These titles are used in the widest sense, and it is proposed to deal with them individually at greater length. Other causes of difficulty, such as soluble and insoluble inclusions, oxides, suspended slag particles, etc., are felt to be outside the scope of the present consideration, and to lie within the realm of pure metallurgy.

The Metal.

Whenever an unforeseen cavity occurs in a casting, or a casting cracks where it should not, the moulder insists that it is due to bad metal. Now, although every good metallurgist knows that this is not so, there is no doubt that the properties of various types of steel vary very considerably, not only in the solid, but in the molten state, and also during the passage through the freezing range.

In the early days of the electric furnace it was commonly thought that the advent of electric melting and the extremely high temperatures thereby rendered available marked the dawn of a millennium when it would be possible to charge any old ferrous scrap into the furnace and to convert it into the very finest soft steel, shear-quality steel or tool steel at will. This dream has not been realised, and it is now known that the electric furnace, whilst capable of producing the very finest steel, can only do so under highly skilled and expert control, and from reasonably clean and suitable raw materials Similar remarks apply to the other important steelmaking processes, *i.e.*, the converter and the open-hearth furnace. The original method of producing steel in the modern sense is to-day economically the least important; that is, the crucible process. It is readily admitted that the crucible method does produce a steel having superior properties both in the foundry and in the testing shop. This has been the subject of very considerable discussion from time to time, but it is now fairly generally agreed that the inherent properties of crucible steel are derived from the extremely pure ores which are used, and from the low-temperature methods of reducing them to iron, as well as from the absence of any violent change in composition during subsequent remelting. This matter, however, is outside the scope of the present discussion, and it must suffice to say that, whilst crucible steel is undoubtedly the best for the moulder to handle, the obvious limitations of the process prevent its being used to any great extent.



It may now be assumed that the vagaries of whatever process is used are fully understood by the melting department, and proceed to a consideration of defects as they commonly occur.

Design.

It is felt that this aspect of the matter could more profitably be dealt with before a meeting of mechanical or constructional engineers, since they are the people who make the designs to which the moulder has to work, but it may be profitable to consider a few of the more glaring faults. The majority of badly-designed steel castings are the result of one or both of two things:—(1) The development of small units of high power, necessitating higher speeds, higher temperatures and greater stresses in the individual members of a machine, and (2) the endeavour to adapt existing cast-iron designs in order to obtain greater strength for the same weight, or the same strength for less weight.

The first has caused the design of castings of a very light complex nature with sudden and violent changes of section, and the second makes a call for castings which, although simple and easy in cast iron, are difficult and troublesome in steel. The pouring temperature of steel being about 300 deg. C. higher than cast iron, and the contraction about double, the difficulties are increased in proportion. Also, steel has a very short freezing range, which prevents easy feeding.

In Fig. 1 an attempt has been made to show this diagrammatically. Iron is poured between 1,300 deg. C. and 1,400 deg. C., and cools normally to about 1,150 deg. C. At this temperature there is a slowing-up of the cooling rate due to the latent heat of fusion, separation of carbides, graphite, etc.; in some irons there is actually a rise in temperature at this stage, the rise varying with the carbon and silicon content. During this stage the metal solidifies fairly slowly, and is able to feed itself from the risers or headers provided. There is also a marked expansion due to structural changes in the metal itself at certain temperatures, and this helps to counteract the natural shrinkage and contraction of the metal. When completely solid the casting cools slowly to room temperature.

Steel, however, is cast at 1,550 deg. C. to 1,650 deg. C., and freezes quickly at about 1,500 deg. C. Unless headers and design are such as to allow the liquid metal very quickly and easily to fill any cavity formed, an unsound casting is the result. There are, of course, innumerable complications caused by composition, casting temperature, etc., and also many other checks in the cooling speed due to structural changes in the metal in both cases. But the main fact is that owing to the long freezing range, or change from liquid to solid, cast iron feeding can readily be performed, but with the short time available with steel greater difficulty is encountered.

The freezing range becomes shorter as the quality of the iron increases, and in the case of high-test irons and malleable irons a special technique has been developed to ensure soundness. In the case of the very low carbon irons made especially for phenomenal strength the foundry practice necessary is very similar to that for steel.

The temperature of the liquid steel is very near to the fusion point of the moulding sands used. Small thin projections of sand often fuse and cause unsoundness in the casting, or difficulty in machining due to fused sand being entrapped in the metal. The golden rule regarding uniformity of section must be too well known to need elaboration. But it must be remembered that, although uniformity is a great help, it does not of itself ensure soundness. Those are the basic facts to bear in mind in design. The following illustrations will demonstrate the matter more clearly. Fig. 2 shows a plain cylindrical casting which would form a cavity or draw as shown on the left. The centre figure shows how this could readily be made sound in cast iron with a riser, which may or may not require rod-feeding. (Other methods, of course, suggest themselves, such as pencil gates.) And the figure on the right shows the head which would be necessary in steel. The shape of this head may be varied somewhat according to personal ideas, but the main features of a large reservoir of liquid metal with easy access to the casting must be maintained.

Fig. 3 shows the basis of a very favourite design of hub casting. Obviously it is impossible to feed the heavy centre portion through the thinner surrounding sections, and it was only after very bitter experience that the centre portion became generally lightened, as shown by the dotted lines.

Fig. 4 shows a casting with the small projections of sand which are always a potential cause of trouble. The bosses must be machined on the face, and the machinist naturally demands tool clearance for his bits. But in many cases it has been found more economical to machine away the little extra metal behind the boss than to suffer the numerous rejections resulting from fusing or blowing off the tiny sand projection.

Fig. 5 shows a very simple modification of design which frequently saves endless trouble. On the left is shown the usual cruciform section of strengthening ribs. In some cases the effect of the meeting of the four sections at the centre is to make a section so heavy as to require feeding. If the arms are staggered as shown on the right the bars may be cast satisfactorily with no feeders other than those provided to ensure soundness in the body of the casting.

* A Paper read before the Middlesbrough Branch of the Institute of British Foundrymen, Mr. S. P. Thorpe presiding. The Author is Vice-President of the London Branch and on the Metallurgical Staff of Messrs. Lake and Elliot, Limited.

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These few examples are very simple instances of the effect of design, but they are sufficient to show what improvements can be made if the designer will only "listen to reason." But the object of this Paper is to consider the prevention of defects in the castings which founders are compelled to produce whether they approve of the design or not.

Cracks.

It is probable that cracks cause more heart-burning than any other defect. There appears to be an infinite variety, from the good old tear which parts a casting into two pieces down to the faint line on a face which is only discovered after expensive machining operations have been carried out.

A consideration of the difference in volume between the molten metal and the solid casting will readily show that, unless some preventive steps are taken, cracks are bound to occur in steel castings. The linear contraction is about 1 in 48, or just over 2 per cent., and the reduction in volume during the change of state or phase and the subsequent solid contraction is upwards of 6 per cent. These figures vary somewhat according to the design of the casting, a long thin casting contracting more, and a short thick casting less, than the usual standard allowances.

When this Paper was first considered, a list was begun of the possible varieties of cracks. When a round dozen was reached, with as many more still to go down, it was decided to tackle them in a different manner. After further thought it was decided that all cracks could be classified under four main headings, as follow:—(1) Cracks caused by carelessness and absence of provision to allow for the more obvious contractions; (2) cracks caused by inadequate feeding, usually at a change of section or a re-entrant angle; (3) plain contraction cracks resulting from the casting contracting differently from expectations; and (4) cracks caused by weakness of metal sections. (This might possibly be a subdivision of Class 2.)

If these are dealt with in order some suggestions may emerge which will be of general use.

Cracks Due to Carelessness.

To the foundry foreman or manager the necessity of removing any obstruction to the free contraction of the metal is so obvious as hardly to necessitate discussion. Yet a few days ago the author saw some cylindrical castings, 5 ft. long, which were fractured into two pieces because the headers at either end of the casting had fouled the box bars! It is impossible to over-emphasise the necessity of preventing any part of the mould or core remaining rigidly between two faces of the casting after freezing has begun. The use of oil sand is invaluable because of the destruction of the bond under heat, but even with oil sand it is not safe to rely on the removal of the bond ensuring complete freedom for contraction. Even perfectly dry unbonded sand offers some resistance, and it is advisable to make arrangements for the complete removal of as much sand as possible.

It is not generally realised that the coefficient of friction between the contracting casting and the sand is high enough to act as a strong brake to the free contraction of the casting. In the case of long castings of light section with a high length to breadth or thickness ratio it is often necessary to help the natural contraction by means of screw jacks or cranks placed at the ends of the casting. Locomotive frames are a good example of this method, the contraction of the casting being followed up by jacks carefully timed by stop-watch. Webs or "cracking-pieces," as they are sometimes called, are frequently used, but in the case of long castings it is often necessary to make them so thick in order to ensure their "running" as to prevent them freezing and contracting quickly enough to do any real good.

It is very interesting and instructive to study the contraction of a long casting which has a runner at one end only. It is invariably found that the major portion of the contraction is towards the runner. The casting frequently "leaves the mould" by a large amount at the end furthest from the runner, whilst the runner end is still in contact with the mould. This is probably due to the chilling and rapid cooling of the metal which first enters the mould, then as the contraction occurs in the later freezing portions near the runner, the already solidified and partially contracted portion is drawn towards the runner. If this action is studied and borne in mind much time and energy may be saved when releasing or "freeing" a casting with bars, etc., because even if the headers and runner are eased in the mould, the grip of the metal on the sand at that end is sufficient to draw the solid portion further away along the mould.

It is possible to quote many other instances of the necessity and methods of releasing castings to allow of easy contraction. The ideal would be the complete removal of the casting from the restrictions of the mould immediately the outer envelope of the metal is solidified, together with some means of maintaining the headers in a liquid state until the whole of the casting is frozen. Unfortunately this is not possible at the present stage of development, and we can only strive to get as close to it as we can with such means as come to hand.

(To be continued.)

Colour in Metal.

By An Architect.

Colour goes far in adding an attraction to anything, and possibly insufficient attention may have been paid to the question of colour in metalwork.

We know iron when fresh from the foundry bed to be grey, gold to be yellow, and so on. But why should not a metal object be red, blue, or any other colour? A variety of colours for metal figures and articles, not as applied to the outer surface, but as embodied in the whole substance of the alloy of which the objects are made, can be obtained. It is but a matter of adding to or reducing from the several parts of which the alloy is made. By adding more copper we get a deeper tone to brass, by reducing the amount of copper we get a lighter colour. Of the number of colours to be obtained for the actual substance of any object it is impossible to form any idea. If we were to set out to make a different-coloured metal article by using different parts of each metal to make the alloy vary in each object, we should certainly find that no bench would contain the articles, however small each might be. They would amount to hundreds of thousands. Indeed, carried to the extent loved by mathematicians, the figure might well run into millions. In the days of the one-pound piece the colour varied considerably, and it may be safely stated that not two brass lecterns issued from two factories to-day are of exactly the same colour.

Brass in the crucible exhibits often the most exquisite colouring, an iridescence often of transcendent beauty, to which neither gold nor silver can be in any way compared. It is not without interest that we note the colouring of a new casting to be of exactly the same quality as we see in a living elephant, both indicate the embodiment of rugged strength.

Sir Roberts-Austen, in his "Metallurgy," relates the result of an experience he once had. He tells that he "found that gold alloyed with 10 per cent. of aluminium is brilliantly white, but from this point as aluminium is added the tint deepens until flecks of pink appear and when 78 parts of gold are added to 22 parts of aluminium, an intensely ruby-coloured alloy, $Au\ Al_2$, is obtained."

A singularly striking alloy is to be seen in exhibit No. 1067 in the Percy collection at the Science Museum at South Kensington. This exhibit shows an alloy of a very beautiful golden colour, the substance being made up of 95 parts of copper to 5 of aluminium.

Superficial colouring has long been applied to metal objects, why should not figures be cast the substance of which is made up of alloys exhibiting a more or less vivid colouring in place of the brown or white commonly met with. It is certainly possible that the cost of production might commercially prohibit the undertaking as a business proposition, but those with the appliances for the necessary operations might find their experiments result in an unexpected value.

West Yorkshire Foundrymen at Dinner.

(Concluded from page 85.)

but with grit and determination would see a revival. Recovery would not be sudden, but would be a quiet and steady one and he believed they would see it in 1933 and they could look forward in a spirit of confidence. The Institute of British Foundrymen was a worthy organisation, doing an excellent work, and he hoped it would go from strength to strength and continue to be a real service asset to the industry.

Mr. R. D. Welford (Senior Vice-Chairman of the West Yorkshire Branch), responding to the toast, said they must all agree with Mr. Hepworth's suggestion that the Institute would fill a long-felt want if it brought about a better co-ordination between the scientific and technical side and the practical side. Up to something like 20 years ago, of course, there was little in the way of a scientific aspect to the foundry industry, but even in those days—as since—the foundry craft had never failed the engineer. One recalled that when the first cylinders were required for ships' engines the engineers had no means of boring the cylinders, and it was a foundryman—Wilkinson—who invented and constructed the first machine to do that work. If there had been a lack of science in foundry work, the engineering firms who employed the foundrymen must take a full share of responsibility for that in the lack of equipment granted to the foundry. The foundry, as a matter of blunt fact, had always been rather in the position of the Cinderella of the engineering industry, but, in spite of neglect, it had always filled the bill. In the past 20 years or so the importance of the foundry had received better recognition, and by that fact, and even more because of the enterprise within its own personnel, it had made phenomenal progress, especially on the metallurgical side. Even in the old days, without science, the practical foundryman knew cause and effect and how to apply them in the making of good castings.

Turning to the question of technical education, the greatest difficulty in the foundry industry to-day, said Mr. Welford, was not so much to find teachers as to find young men ready to be taught. Under the Craft Certificate scheme of the Institute there was a good class in foundry practice at Huddersfield, but great centres like Leeds and Bradford had not yet managed to raise enough interested young men to establish such classes. One imagined that if the engineering employers could see their way to allow genuine students among their young foundrymen to have a little time off during the day, excellent classes could be set up in all centres. It was asking rather a lot to expect the average young man, in these days of so many counter-attractions, to go to night classes in foundry practice after a heavy day of physical work in the foundry. The establishment of classes depended, of course, entirely on the willingness of the younger men.

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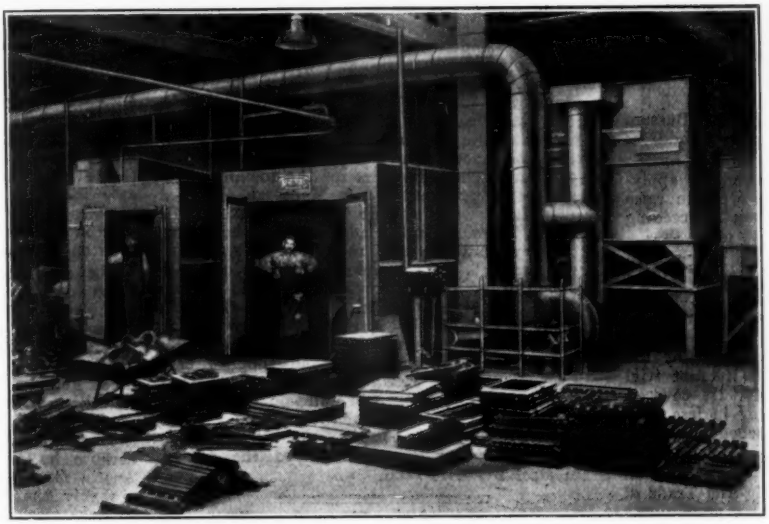

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This Week's News in Brief.

Trade Talk.

Messrs. John Dickinson & Sons, Limited, are to extend their erecting shop at their Palmers Hill Engine Works, Sunderland.

Mitsui & Company, Limited (Mitsui Bussam Kaisha, Limited), announce their change of address to Royal Mail House, Leadenhall Street, E.C.3.

The Great Western Railway Company is applying to Parliament this session for powers to raise new capital to an aggregate not exceeding £8,000,000.

On Sunday last fire broke out in the pattern shop at the Furness Foundry of Messrs. David Caird, Limited, Barrow, and considerable damage was done, but arrangements have been made to carry on business as usual.

A new Diesel-electric locomotive built by the Armstrong-Whitworth Company made its first trial trip recently on the L.M.S. Railway. It covered the 50 miles from Euston to Bletchley in less than 50 min., despite heavy fog, and reached speeds of over 70 m.p.h.

The joint secretaries of the Board of Conciliation for the regulation of Wages in the Pig-iron Trade of Scotland have been informed by the accountants that the certified returns for October, November and December, made by the employers, show an average net selling price of £3 5s. 8d. This means that there will be a reduction of 2 per cent. in the wages of the workmen on basis rate.

In connection with the scheme for the production of basic-Bessemer steel at Corby, in Northamptonshire, Messrs Stewarts & Lloyds, Limited, have placed an order for a large mechanical shovel with Messrs. Ransomes & Rapier, Limited, of Ipswich. The shovel will be used for removing the 50 ft. of overburden on the ironstone field at Corby. The shovel will weigh 500 tons and will be capable of dumping per minute approximately 9 cub. yds. of material at a radius of 100 ft., and at a height of 68 ft.

A contract has been signed between the Portuguese Government and Messrs. Yarrow & Company, Limited, Glasgow, for a torpedo-boat destroyer similar to the four torpedo-boat destroyers which the firm already have under construction for that Government. The hull of this fifth destroyer will be built in Lisbon, but the machinery and boilers will be manufactured by Messrs. Yarrow & Company in Glasgow. The steel material for the hull will be supplied by the Steel Company of Scotland, Limited, and shipped to Portugal.

A limited liability company, Compagnie pour l'Exportation des Aciers, Tubes et Matériaux de Construction (Actuma), with a capital of 12,500,000 fcs., has been registered at Paris for the export, particularly to South America, of pig-iron, sheets, plates, tubes and structural steel. The following are associated in the formation of the new company: Société des Aciéries de Longwy; Louvroil et Recquignies, Société Française pour la fabrication des Tubes et Emboutis; Société Lorraine des Aciéries de Rombas; Société des Hauts Fourneaux, Forges et Aciéries de Differdange, Saint-Ingbert, and Rumelange, and the Compagnie de Vente de Produits Métallurgiques Davum-Exportation.

The armature of an 18,000-h.p. rolling-mill motor for South Africa, built by the English Electric Company, Limited, Stafford, was conveyed from Stafford to Birkenhead for shipment last week. This machine formed one of the interesting exhibits during the recent exhibition of developments at the Stafford works of the company, and was described in our issue for November 11, 1932. The complete motor weighs 150 tons and has overall dimensions of 20 ft. by 21 ft., the armature weighing 58 tons net (61½ tons gross) and having a diameter of almost 11 ft. The height to the top of the armature from the track level when loaded on a special well trolley was 13 ft. 4 in. This height and the diameter of the armature are well outside the standard gauge for railway traffic, and consequently special arrangements were made for the journey from Stafford to Birkenhead. The armature was conveyed on an 80-ton L.M.S. trolley. The special train left Stafford at 6.52 a.m. on Sunday morning, January 15, and arrived at Birkenhead by noon of the same day, and the armature was immediately shipped on board the steamer "Clan Urquhart."

We are informed that Mr. Sydney Evans has been appointed Chairman of Engineers Agents, Limited, 46, Victoria Street, S.W.1. The company acts as the London office of the Foundry & Engineering Company (West Bromwich), Limited, Sandwell Road, West Bromwich, and Messrs. Grandidge & Mansergh, Limited, Wheathill Street Works, Salford, Manchester. The former is well known as the patentees and manufacturers of the Acme vertical continuous mould dryers, and the general range of Acme drying stoves for the foundry. The latter company, Grandidge & Mansergh, Limited, are manufacturers of the well-known "G. and M." coal dust, blacking, and in addition the whole range of foundry materials and requisites. Mr. Sydney Evans also acts as the London correspondent of Messrs. Pittevil & Company, 1, Place du Champs de Mars, Brussels, who hold the British manufacturing rights of the Sesci rotary furnace, and are also exclusive agents for Great Britain of a number of foundry equipment and supplies firms such as Messrs. T. Ketin & R. Thiriart, Liège; S.A. Silica, etc., and that in addition to the Sesci rotary furnace, this group of works puts them in a position to supply a complete range of first-class foundry equipment, in addition to the famous Silica steel founders sand.

Personal.

Mr. Wesley Lambert, C.B.E., Past-President of the Institute of British Foundrymen, is to read a Paper on the "Manfacture of High-Class Propellers" before the Institution of Engineering Inspection on February 8.

Mr. E. V. Ronceray has been conferred the honour of being created an officer of the Legion of Honour. It is also an open secret that he is shortly to be elected on honorary president of the Association Amicale et Mutuelle de Fonderie.

Mr. Alfred L. Kewney, manager of the repair department of Messrs. Palmers Shipbuilding & Iron Company, Limited, Jarrow and Hebburn, is leaving to take up an appointment with Messrs. Amos & Smith, Limited, engineers and ship repairers, of Hull.

Mr. W. Williams, the president of the Wales and Monmouth Branch of the Institute of British Foundrymen, has opened new foundry premises which were for many years occupied by the late Mr. Charles Jones, a Past-President of the Institute of British Foundrymen.

Mr. A. E. Mascall has been appointed general manager of the Parkhead Works of Messrs. William Beardmore & Company, Limited, of Glasgow. Mr. Mascall, who is well known in engineering circles, was until recently in charge of the departments responsible for the production and machining of all classes of forgings and the rolling of armour plate at the Atlas Works of Messrs. Thomas Firth & John Brown, Limited, Sheffield.

Wills.

Macfarlane, Walter, of Glasgow, iron-founder	£49,796
Whitwell, J. F., of Great Ayton, Yorks, ironmaster	£25,048
Gillott, John, of Sheffield, iron, steel and metal merchant	£5,984

Foundry Equipment in 1932.—Mr. D. H. Wood wishes us to correct the statement appearing on the second column (page 76) in our last issue. This should read: "Less than five years ago, the number of British foundries employing automatic sand-handling plant could be counted on one hand."

Incombustible Building Materials.—The British Standards Institution has issued "British Standard Definitions for Fire Resistance, Incombustibility, and Non-Inflammability of Building Materials and Structures" (B.S.S. No. 476—1932). Those who have anything to do with the fire protection of buildings have long felt the need for authoritative definitions. In the absence of these the meaning of the terms used has been a matter for the decision of the various officials administering the building laws, which has unavoidably resulted in anomalies and uncertainties in building. The British Standard definitions will automatically clear up these difficulties. Copies of this specification may be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2s. 2d. post free.

Obituary.

We regret to record the death of Dr.-Ing. Friedrich Freytag, at the age of 53 years, who was a prominent figure in German technical circles. He had written many valuable contributions to the technical Press, besides being the author of various works on foundry subjects. When the Testing Commission for Patternwork was appointed he was elected its president.

The death occurred after a very short illness, on January 25, of Mr. Tom Parkin, of St. George's Square, St. Annes-on-Sea, aged 74. Mr. Parkin, at the early age of 25, commenced business at Moston as a malleable ironfounder, and up to the time of his death he was the governing director of the Moston Malleable Castings Company, Limited, Newton Heath, Manchester.

We sincerely regret to announce the death, through a motor-car accident, of Mr. Georges Fosseprez, the managing director of the Mons Steel Foundry Company. It will be remembered that we published only a fortnight ago a trenchant article from his pen on the situation of the Belgian Steel Foundry Industry. Mr. Fosseprez was very well known throughout the steel foundry industry of Great Britain, because of his connection during the war with the Ministry of Munitions and also because he erected the original foundries at the Austin Company's works at Longbridge. He was probably the first founder in the world regularly to make steel castings from a rotary pulverised fuel-fired furnace.

Contracts Open.

Dublin, February 10.—Rolled steel, for the Commissioners of Public Works. Mr. T. Cassedy, secretary, Office of Public Works, Dublin.

Eyam, February 18.—Supply and laying of 960 yds. of 3-in. and 4-in. dia. cast-iron pipes, with fittings, etc., for the Bakewell Rural District Council. Messrs. Brady & Partington, Chapel-en-le-Frith. (Fee £5, returnable.)

Fingringhoe, February 22.—100 tons of cast-iron pipes, etc., for the Lexden and Winstree Rural District Council. Messrs. Sands & Walker, Milton Chambers, Nottingham. (Fee £2 2s., returnable.)

London, February 20.—Five steel pontoons, overall dimensions 14 ft. by 7 ft. by 5 ft., for the London County Council. The Chief Engineer (C), The Old County Hall, Spring Gardens, London, S.W.1. (Fee £5, returnable.)

London, E.C., February 9.—Cast-iron buoy sinkers, for the Corporation of Trinity House. Mr. H. T. Miller, secretary, Trinity House, Tower Hill, London, E.C.3.

Sherborne, February 8.—Supply and laying of about 8,500 yds. of 3-in. and 2-in. cast-iron mains, etc., for the Rural District Council. Mr. A. J. Allen, Half Moon Street, Sherborne, Dorset. (Fee £3 3s., returnable.)

Patent Specifications Accepted.

The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken

414. Metallges. Akt.-Ges. Process of rolling compounds of metals with non-metals or alloys of these compounds with metals. 385,119.

11,786. Athey, J. W. Rotary core-machine. 385,177.

13,558. Triggs, W. W. (Freyn Engineering Co.). Test rods, more particularly test rods for blast furnaces. 385,195.

21,688. International General Electric Co., Inc. Drives for rolling mills. 385,237.

34,225. Gibbons Bros., Ltd., and Bridgford, T. E. Muffle furnaces. 384,798.

24,150. Matthews, E. F. Methods of intimately uniting a body of metal having a low melting-point with a body of metal having a high melting-point. 384,367.

29,575. Reuss, O. Distribution of the blast in cupolas. 384,042.

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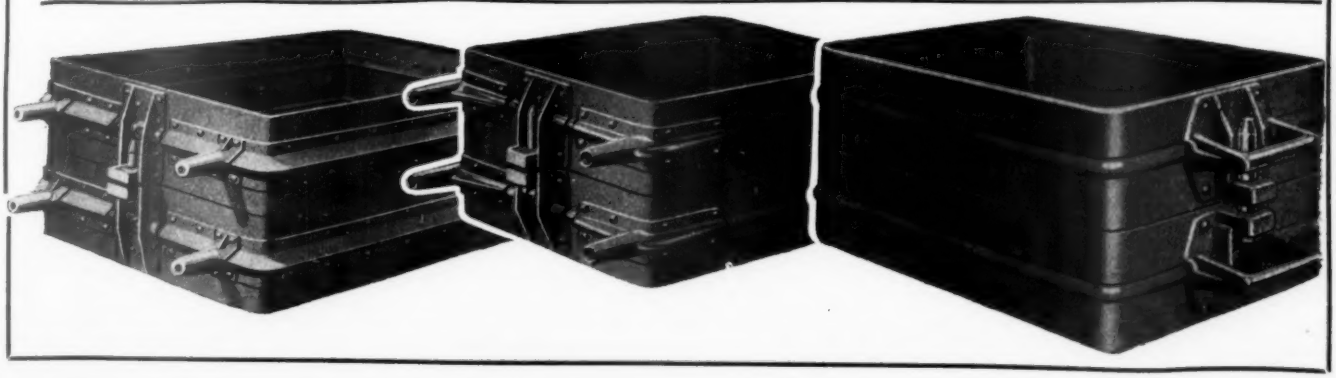

Raw Material Markets.

Business in the iron and steel markets is very limited at the moment, the majority of users being apparently well supplied. The new price zones which have been arranged for Cleveland pig-iron have unfavourably influenced trading, but there should be an improvement when the market becomes used to the new conditions. The consumption of steel, both finished and semi-finished, shows little expansion. On the other hand, increasing activity is being witnessed in the scrap-iron markets and prices are firm.

Pig-Iron.

MIDDLESBROUGH.—Delivered prices for Cleveland iron have been revised somewhat. The ironmasters officially intimate that the price of No. 3 Cleveland pig-iron is to remain at 62s. 6d. to customers in the Teeside area, that is, Middlesbrough, Stockton, Thornaby and South Bank. Outside that area, to a line 50 miles west of Middlesbrough and then directly south to the Midlands area and north to the Scottish border, the price of No. 3 becomes 64s. 6d. West of this 50 miles line and then directly north to the Scottish border and south to the Midlands area, the price of No. 3 is 69s. No. 1 Cleveland continues at 2s. 6d. above the price of No. 3, while No. 4 forge and foundry are each quoted 1s. below the price of No. 3. For sales to Scotland makers have fixed rates at 62s. 9d. delivered Glasgow and 59s. 9d. delivered Falkirk. This represents an advance of fully 7s. 6d. on prices before the zoning scheme came into operation.

East Coast hematite is in better demand, following the increase in prices of the Cleveland foundry grades. Consumers are turning to the hematite grade, both because of its cheapness, and also the fact that hematite prices may shortly increase. For the moment, however, quotations remain at 59s. for mixed numbers and 59s. 6d. for No. 1 quality.

LANCASHIRE.—Several jobbing foundries in this area are better employed, and a slightly increased tonnage of iron generally is being called for from the furnaces. It is hoped that this improvement will continue. There is still no change in the general price position, offers of Midland brands of No. 3 iron—Derbyshire and Staffordshire—for delivery to users in the Manchester zone, being on the basis of 67s. per ton, with Northamptonshire at 65s. 6d., Scottish foundry at around 82s., East Coast hematite at about 75s. 6d. and West Coast hematite at 81s. per ton.

MIDLANDS.—The month of January, as far as the pig-iron market is concerned, has closed on a very poor note in this district. Deliveries have been at a low level, and new business has, so far, offered little hope of improvement this month. The new makers' agreement means that Midlands and Cleveland brands of iron are on sale in all markets at practically the same prices. Quotations were reconsidered last week, but no changes were made, the present controlled prices being 62s. 6d. for Northants No. 3 and 66s. for Derbyshire. North Staffordshire and Lincolnshire No. 3, which prices include delivery to Birmingham and Black Country stations. There is no sign of Continental foundry iron becoming competitive in this district. The Scottish price for No. 3 is from 83s. 6d. to 85s. 6d. per ton. There is no improvement in the demand for hematite pig-iron. Prices are by no means firm for Welsh or East Coast hematite, quotations varying, according to quantity and quality, from 75s. 6d. to 80s. per ton for No. 3 or mixed numbers. West Coast iron is controlled at 84s. 6d. per ton delivered.

SCOTLAND.—The pig-iron market in Scotland, normally at a low rate of activity, has been further disorganised by the increases in the prices of English brands. The price of No. 3 Middlesbrough iron at Falkirk has been officially raised to 59s. 9d. per ton, and for Glasgow delivery to 62s. 9d. per ton. Scottish pig-iron remains unaltered at 67s. 6d. for No. 3, f.o.t. furnaces, with 2s. 6d. per ton extra for No. 1.

Coke.

Conditions remain stationary in the foundry-coke market, there being no signs of any recovery from the present low level of buying. Prices remain more or less unchanged, Durham coke being quoted at 34s. to 38s. per ton and Welsh coke at 30s. to 45s. per ton, according to quantity and analysis. These quotations are for delivery in the Midlands area.

Steel.

Quiet conditions continue to rule, but, although few important transactions have been reported of late, the volume of business has been maintained. The position in the semi-finished steel department has shown little change over the past week or two. Some sales of Continental material are reported at cheap prices, but these have been small, and nearly all the business now being placed goes to the British makers. Few transactions of any bulk, however, have been reported, as consumers pursue a policy of buying from hand to mouth. Business in finished steel has increased, and although the home market has been quiet, there has been some improvement in exports, particularly to some of the Empire markets. Continental competition is severe in the oversea markets, prices quoted from this source having lately developed weakness.

Scrap.

In inverse ratio to the demand for pig-iron, there seems to be an increasing call for supplies of scrap iron. Many new orders continue to be taken in nearly all districts, in spite of the fact that many foundries have recently been in the market. In the Cleveland area there is the possibility of higher prices, in view of the increased quotations for Middlesbrough pig-iron. Machinery metal is very firm this week at 43s. per ton, and heavy metal at 40s. There is a steady demand in the Midlands, where machinery metal is changing hands at 47s. to 50s., delivered. Clean light cast-iron scrap is scarce, up to 40s. being offered. Slightly more activity is also being seen in the South Wales market, where machinery metal is quoted at 47s. 6d. to 50s., good heavy metal at 40s. to 42s. 6d., and clean light metal at about 40s. per ton delivered. Consumers in Scotland are making heavier inquiries for scrap, and sellers are asking 47s. 6d. to 49s. for machinery quality, in pieces not exceeding 1 cwt., which is somewhat difficult to obtain, and 44s. to 45s. for ordinary cast iron to the same specification.

Metals.

Copper.—The industrial demand for copper remains fairly steady, but at a low level, and market quotations are more or less unchanged on the week. The copper situation in the United States shows no sign of improvement at the moment. Rumours are circulating, however, of an increasing disposition on the part of American producers to make a voluntary cut in their outputs this spring, and it is believed that informal international discussions have been held lately on similar lines.

Prices have been :—

Cash.—Thursday, £28 11s. 3d. to £28 12s. 6d.; Friday, £28 10s. to £28 12s. 6d.; Monday, £28 5s. to £28 6s. 3d.; Tuesday, £28 10s. to £28 12s. 6d.; Wednesday, £28 6s. 3d. to £28 8s. 9d.

Three Months. — Thursday, £28 15s. to £28 16s. 3d.; Friday, £28 15s. to £28 17s. 6d.; Monday, £28 8s. 9d. to £28 10s.; Tuesday, £28 13s. 9d. to £28 16s. 3d.; Wednesday, £28 11s. 3d. to £28 12s. 6d.

Tin.—This metal is in disappointing demand at the moment, and, in view of the disturbed conditions on the Continent, and the lack of improvement in the American industrial situation, the present steadiness of the market seems unjustified. A lower level of prices in the near future is not an unlikely possibility.

Prices of standard tin have been :—

Cash.—Thursday, £146 15s. to £146 17s. 6d.; Friday, £146 7s. 6d. to £146 10s.; Monday, £146 17s. 6d. to £147 2s. 6d.; Tuesday, £148 5s. to £148 7s. 6d.; Wednesday, £148 10s. to £148 12s. 6d.

Three Months. — Thursday, £147 10s. to £147 12s. 6d.; Friday, £147 to £147 5s.; Monday, £147 10s. to £147 12s. 6d.; Tuesday, £148 15s. to £148 17s. 6d.; Wednesday, £149 7s. 6d. to £149 10s.

Spelter.—The market suffered a severe setback on Friday, following the unconfirmed report that the members of the International Zinc Cartel had been unable to settle their internal grievances and that the Cartel was to be dissolved forthwith. Discussions are still proceeding between the parties concerned, but hopes of a settlement are now rather remote. It would be a pity, however, if the organisation is finally abandoned, as it has maintained an efficient and very necessary control over international production. The dissension was largely due to the desire of certain parties for large increases in their quotas. How the market will fare if all control is taken away remains to be seen, but lower prices are regarded as a certainty in most quarters. The demand from manufacturers for this metal is poor at the moment, particularly as regards high grade.

Price fluctuations :—

Ordinary.—Thursday, £14 2s. 6d.; Friday, £13 11s. 3d.; Monday, £13 11s. 3d.; Tuesday, £13 18s. 9d.; Wednesday, £13 18s. 9d.

Lead.—The position in the consuming industries is very patchy at the moment, the building-material trade being the most active outlet. An intensive price war is being waged in the lead pipe and sheet trade by a new plant operating outside the Lead Manufacturers' Association. Prices remain fairly steady in the lead market, although Friday's weakness in spelter was a disturbing factor.

Daily market prices :—

Soft Foreign (Prompt).—Thursday, £10 10s.; Friday, £10 8s. 9d.; Monday, £10 10s.; Tuesday, £10 13s. 9d.; Wednesday, £10 13s. 9d.

Book Review.

Definitions and Formulæ for Students of Metallurgy, compiled by E. R. TAYLOR, A.R.S.M. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 6d. net.

This little book was sent to us by the author, as, perhaps, the publishers thought that a sixpenny pamphlet was unworthy of editorial notice. Actually, such works are extremely important, as they can command a very wide circulation. In general, his definitions are excellent, but we think that the author should have collaborated with more interests in order to ensure better definitions. For instance, we are not quite satisfied with Martin steel, shear steel, chaplets, coremaking machines, temper, just to pick out a few at random. The spelling mistake, in connection with Martin steel, is particularly unfortunate, as it is liable to give the impression of common origin, with martensite. We think that despite these small shortcomings the book is excellent value for sixpence.

V. C. F.

Iron Chains.—At a meeting of the Wolverhampton and District Engineering Society held recently, MR. J. PUMP read a Paper on the subject of "Chains," in the course of which he dealt with the essential requirements of wrought iron used in the manufacture of chains, and stressed the importance of using the correct fuel in the course of the heating process. A chain needed lubricating, but rarely received such attention. Of all modern industries the making of chain was one of the least mechanised, and still depended very largely upon the manipulative skill of the chainsmith, who formed and welded the links one at a time.

Converting Inches to Millimetres.—An American Standard value to be used by industry in converting inches to millimetres was recommended by a general conference held under the auspices of the American Standards Association, following a request of the Ford Motor Company. Representatives of eighteen industrial groups having an interest in precise measurements and methods of limit gauging were present. The conference unanimously recommended the conversion factor of 1 in. = 25.4 mm. to become the American Standard value for industrial use, replacing for this purpose both the official ratio 25.40005 and the rounded value 25.4001 given in certain handbooks and tables.

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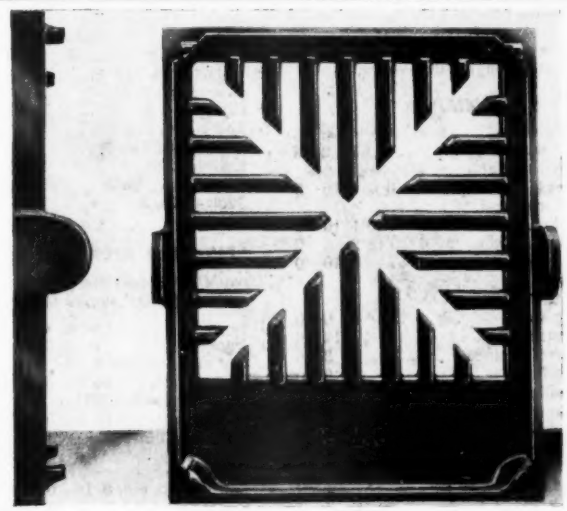

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COPPER.

	£ s. d.
Standard cash	28 6 3
Three months	28 11 3
Electrolytic	32 15 0
Tough	30 0 0
Best selected	30 10 0
Sheets	61 0 0
India	41 0 0
Wire bars	33 0 0
Do., March	33 0 0
Do., April	33 0 0
Ingot bars	33 0 0
H.C. wire rods	35 10 0
Off. av. cash, January	28 12 0⅝
Do., 3 mths., January	28 17 10½
Do., Sttlmnt., January	28 12 1½
Do., Electro, January	33 10 3½
Do., B.S., January	31 7 6
Do., wire bars, January	33 15 8½
Solid drawn tubes	9½d.
Brazed tubes	9¼d.
Wire	6½d.

BRASS.

Solid drawn tubes	8¾d.
Brazed tubes	10½d.
Rods, drawn	7¾d.
Rods, extd. or rlld.	4¾d.
Sheets to 10 w.g.	7½d.
Wire	7¼d.
Rolled metal	7d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5¼d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£ s. d.
Standard cash	148 10 0
Three months	149 7 6
English	149 10 0
Bars	151 15 0
Straits	154 0 0
Australian	151 5 0
Eastern	151 10 0
Banca	154 5 0
Off. av. cash, January	145 15 10½
Do., 3 mths., January	146 8 11¼
Do., Sttlmt., January	145 16 5½

SPELTER.

	£ s. d.
Ordinary	13 18 9
Remelted	13 15 0
Hard	11 15 0
Electro 99.9	16 15 0
English	14 17 6
India	13 10 0
Zinc dust	21 0 0
Zinc ashes	2 15 0
Off. aver., January	14 9 9½
Aver. spot, January	14 7 7⅞

LEAD.

	£ s. d.
Soft foreign ppt.	10 13 9
Empire	11 0 0
English	12 0 0
Off. average, January	10 12 11
Average spot, January	10 9 2

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	24 5 0
Do., V.M. ex-whse.	23 15 0
Rods	26 0 0
Boiler plates	22 0 0
Battery plates	—

ANTIMONY.

	£ s. d.
English	37 10 0 to 42 10 0
Chinese	27 15 0
Crude	—

QUICKSILVER.

	£ s. d.
Quicksilver	10 5 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon—	
25%	8 0 0
45/50%	13 15 0
75%	19 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£17 7 6
Ferro-tungsten—	
80/85%	1/7½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
2/4% car.	£29 5 0
4/6% car.	£23 7 6
6/8% car.	£22 15 0
8/10% car.	£22 10 0
Ferro-chrome—	
Max. 2% car.	£34 17 6
Max. 1% car.	£37 17 6
Max. 0.70% car.	£40 2 6
70% carbon-free	1/- lb.
Nickel—99.5/100%	£245 to £250
"F" nickel shot	£220 0 0
Ferro-cobalt	7/3 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ⅛ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	2 2 6	
Bundled steel and shrngs.	1 16 0	to 1 19 0
Mixed iron and steel	1 15 6	to 1 19 0
Heavy cast iron	2 4 0	to 2 5 0
Good machinery	2 10 0	
Cleveland—		
Heavy steel	2 0 0	
Steel turnings	1 12 6	
Cast-iron borings	1 3 6	
Heavy forge	2 10 0	
W.I. piling scrap	2 2 6	
Cast-iron scrap	2 0 0	to 2 3 0
Midlands—		
Light cast-iron scrap	2 0 0	
Heavy wrought iron	2 5 0	
Steel turnings, f.o.r.	1 2 6	
Scotland—		
Heavy steel	1 17 6	
Ordinary cast iron	2 2 6	to 2 5 0
Engineers' turnings	1 11 6	
Cast-iron borings	1 12 6	
Wrought-iron piling	2 2 6	
Heavy machinery	2 7 6	to 2 9 0

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	21 0 0
Brass	15 0 0
Lead (less usual draft)	9 0 0
Tea lead	7 0 0
Zinc	8 10 0
New aluminium cuttings	72 0 0
Braziery copper	19 0 0
Gunmetal	18 0 0
Hollow pewter	80 0 0
Shaped black pewter	60 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	59/9
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
,, basic	—
Scotland—	
Foundry No. 1	70/-
,, No. 3	67/6
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
,, fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	—
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/-
Clyde, No. 3	82/-
Monkland, No. 3	82/-
Summerlee, No. 3	82/-
Eglinton, No. 3	82/-
Gartsherrie, No. 3	82/-
Shotts, No. 3	82/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£ s. d.	£ s. d.
Iron—		
Bars (cr.)	9 0 0	to 9 15 0
Nut and bolt iron	7 15 0	to 8 0 0
Hoops	10 10 0	to 12 0 0
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	to 12 0 0
Bolts and nuts, ¾ in. × 4 in.	12 10 0	
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	8 0 0	to 9 0 0
Chequer plts.	10 7 6	
Angles	8 7 6	
Tees	9 7 6	
Joists	8 15 0	
Rounds and squares, 3 in. to 5½ in.	9 7 6	
Rounds under 3 in. to ¾ in. (Untested)	6 15 0	& up.
Flats—8 in. wide and over	8 12 6	
,, under 8 in. and over 5 in.	8 17 6	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 0 0	
Hoops (Staffs)	9 10 0	& up.
Black sheets, 24g. (10-t. lots)	9 10 0	
Galv. cor. shts. ,,	11 15 0	
Galv. flat shts. ,,	12 5 0	
Galv. fencing wire, 8g. plain	14 0 0	
Billets, soft	4 17 6	to 5 7 6
Billets, hard	6 12 6	to 7 2 6
Sheet bars	4 15 0	to 5 2 6
Tin bars	4 15 0	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10¼d.
Sheet to 10 w.g.	11½d.
Wire	11⅝d.
Rods	10½d.
Tubes	16d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.38
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.00
Sheets, galv., No. 24	2.65
Wire nails	1.80
Plain wire	2.10
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	20/- to 22/6
,, furnace	16/- to 16/6
Durham and Northumberland—	
,, foundry	21/- to 25/-
,, furnace	13/6 to 13/9
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	16/-
,, 28×20 ,,	32/-
,, 20×10 ,,	23/-
,, 18¾×14 ,,	16/7½
C.W. 20×14 ,,	14/-
,, 28×20 ,,	29/3 to 29/6
,, 20×10 ,,	19/10
,, 18¾×14 ,,	14/-

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 10 0 to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 5 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Jan.	26 ..	28	11	3	dec. 2/6
,,	27 ..	28	10	0	,, 1/3
,,	30 ..	28	5	0	,, 5/-
,,	31 ..	28	10	0	inc. 10/-
Feb.	1 ..	28	6	3	dec. 3/9

Electrolytic Copper.

		£	s.	d.	
Jan.	26 ..	32	15	0	No change
,,	27 ..	32	17	6	inc. 2/6
,,	30 ..	32	15	0	dec. 2/6
,,	31 ..	32	15	0	No change
Feb.	1 ..	32	15	0	,, ,,

Standard Tin (cash).

		£	s.	d.	
Jan.	26 ..	146	15	0	dec. 2/6
,,	27 ..	146	7	6	,, 7/6
,,	30 ..	146	17	6	inc. 10/-
,,	31 ..	148	5	0	,, 27/6
Feb.	1 ..	148	10	0	,, 5/-

Tin (English ingots).

		£	s.	d.	
Jan.	26 ..	147	15	0	dec. 5/-
,,	27 ..	147	10	0	,, 5/-
,,	30 ..	148	0	0	inc. 10/-
,,	31 ..	149	5	0	,, 25/-
Feb.	1 ..	149	10	0	,, 5/-

Spelter (ordinary).

		£	s.	d.	
Jan.	26 ..	14	2	6	dec. 5/-
,,	27 ..	13	11	3	,, 11/3
,,	30 ..	13	11	3	No change
,,	31 ..	13	18	9	inc. 7/6
Feb.	1 ..	13	18	9	No change

Spelter (Electro, 99.9 per cent.).

		£	s.	d.	
Jan.	26 ..	16	15	0	dec. 5/-
,,	27 ..	16	10	0	,, 5/-
,,	30 ..	16	10	0	No change
,,	31 ..	16	15	0	inc. 5/-
Feb.	1 ..	16	15	0	No change

Zinc Sheets (English).

		£	s.	d.	
Jan.	26 ..	24	10	0	No change
,,	27 ..	24	5	0	dec. 5/-
,,	30 ..	24	5	0	No change
,,	31 ..	24	5	0	,, ,,
Feb.	1 ..	24	5	0	,, ,,

Lead (English).

		£	s.	d.	
Jan.	26 ..	12	0	0	No change
,,	27 ..	12	0	0	,, ,,
,,	30 ..	12	0	0	,, ,,
,,	31 ..	12	0	0	,, ,,
Feb.	1 ..	12	0	0	,, ,,

AVERAGE MONTHLY PRICES OF MARKED BARS (SOUTH STAFFS).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1899	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	9 0 0	9 0 0	9 10 0	10 0 0	10 0 0	10 0 0	8 3 4
1900	11 0 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 10
1901	9 10 0	9 10 0	9 10 0	9 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 16 8
1902	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 7 6
1903	8 5 0	8 5 0	8 5 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 8 9
1904	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 10
1905	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	8 1 8
1906	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	8 15 10
1907	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0
1908	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 5 10
1909	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1910	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1911	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1912	8 10 0	8 10 0	8 10 0	8 15 0	9 0 0	9 0 0	9 0 0	9 8 0	9 10 0	9 10 0	9 10 0	9 15 0	9 1 6
1913	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	9 10 0	9 10 0	9 4 0	9 0 0	9 0 0	9 13 8
1914	8 12 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 14 4
1915	9 0 0	9 0 0	9 3 0	10 2 0	10 15 0	11 10 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	13 10 0	11 5 0
1916	13 10 0	13 10 0	14 13 0	15 0 0	15 0 0	15 0 0	15 0 0	15 10 0	15 10 0	15 0 0	15 10 0	15 0 0	14 18 7
1917	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1918	15 12 6	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	17 0 0	17 0 0	17 0 0	16 6 3
1919	18 0 0	18 10 0	20 0 0	20 0 0	23 0 0	23 0 0	23 0 0	24 12 0	25 0 0	25 0 0	25 0 0	25 5 0	22 10 7
1920	26 17 6	27 0 0	28 0 0	30 5 0	30 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	31 10 2
1921	31 10 0	30 3 4	27 10 0	27 10 0	27 10 0	24 15 0	21 0 0	20 0 0	20 0 0	17 10 0	17 0 0	16 0 0	23 7 4
1922	16 0 0	14 17 6	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 18 1½
1923	13 10 0	13 10 0	13 16 0	14 7 6	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 5 3½
1924	14 10 0	14 10 0	14 10 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 17 6	14 17 3½
1925	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 0 0	14 13 4
1926	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	*		14 10 0	14 0 10
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 0 0	13 0 0	12 18 0	13 15 8
1928	12 10 0	12 10 0	12 10 0	12 2 6	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 2 8½
1929	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	12 10 0	12 2 3½
1930	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1931	12 10 0	12 10 0	12 10 0	12 8 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 3 2
1932	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0
1933	12 0 0	—	—	—	—	—	—	—	—	—	—	—	—

* No quotation available.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

XUM

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3 -

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

ADVERTISER, well known in the Midlands, desires to act as Representative for firms of repute for the sale of pig-iron, coke, sands, etc., or foundry plant and requisites.—Box 324, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

BRASS FOUNDRY FOREMAN desires position; experienced in Admiralty contracts, gunmetal, phos. bronze and manganese castings; 12 years foreman in last situation.—Box 258, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

COMPETENT Foundry Foreman wanted for special work. Willing go abroad.—Write, Box No. ELR 4034, c/o RUDOLF MOSSE, LIMITED, Brettenham House, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager (Non-Ferrous) for important progressive North Country manufacturing Engineers. Good prospects for a young, experienced man of energy and initative with complete knowledge of modern methods and machinery, including small castings and hot pressings.—State age, fullest particulars of experience, and salary (in strictest confidence), to Box 328, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REQUIRED, Representatives with strong, active connection amongst iron, steel and/or non-ferrous foundries in any localities throughout U.K. New Refractory of guaranteed regular quality available; unlimited supply. Very substantial commission basis; merchant firms can apply to sell on merchant basis.—Write, Box 322, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

PRACTICAL Foundry Manager desires engagement. Wide and varied experience, machine tools, light castings, turbine and engine work. Rotary furnace experience. (204)

POSITION required as Works or Foundry Manager, or as Representative. Wide experience in ferrous and non-ferrous foundries with first-class firms. Highest credentials. (205)

YOUNG Foundry Manager requires position or as Assistant. Good general and technical education, sound experience as Moulder and in supervisory capacity. (206)

SITUATIONS VACANT AND WANTED—*Contd.*

PROGRESSIVE position required by young Foundryman with sound practical training on light castings, including stove, grate, bath work, etc. Thorough knowledge machine plate moulding, and also loose pattern moulding. Sound technical training and good general education. (207)

PROPERTY.

MAGNIFICENT

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of Shops.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,

ALBION WORKS, SHEFFIELD.

MACHINERY.

WANTED, Zimmerman Pneumatic Jolt Squeeze Portable Moulding Machine, Type F.R.1, to take box parts up to 16 in. x 14 in.—Apply, with full details, to Box 320, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY PLANT FOR SALE.

Pneulec Rotary Sand Drying Plant, output 1 ton per hour.

No. 9 "Ajax" Pneumatic Jarr Ram Turnover P.D. Moulding Machine.

Sand Mill, 6 ft. dia., Stationary Self-discharging Pan.

"Titan" Cupola, 4 to 5 tons; little used.

Brearley Type Sand Disintegrator.

The above are offered at LOW PRICES before removal.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.,

215, Barclay Road, Warley, near Birmingham.

'Phone: Bearwood 1103.

SAND BLASTING PLANTS FOR SALE

Tilghman Sand Blast Room, 6 ft. x 6 ft. x 8 ft. high.

Tilghman Rotary Barrel, 36 in. x 30 in.

Tilghman Rotary Double Barrel Plant, barrels 24 in. x 20 in.

Tilghman 4-ft. 6-in. x 3-ft. Cabinet Plant.

Tilghman 30-in. dia. Cabinet Plant.

Jackman Rotary Barrel, 30 in. x 24 in.

Each Plant complete with Sand Apparatus, Air Compressor and Exhaust Fan.

Large stock of FOUNDRY PLANT at LOW PRICES.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

215, BARCLAY ROAD, WARLEY,

Nr. Birmingham.

'Phone: Bearwood 1103.

THOS. W. WARD, LTD.

GRINDING MACHINE, Universal, 10" x 30".

MOULDER and SHAPER, vert. spindle, table 24" sq.

FOUNDRY LADLE, Geared, hand-operated, 20" deep x 23" dia. at top.

2 STIRLING W.T. BOILERS, 160 lbs. w.p.

6 Nissen-type STEEL BUILDINGS, 550' x 40' x 19' 10" high.

Write for "Albion" Catalogue.

'Grams: "Forward, Sheffield."

'Phone: 23001 (10 lines).

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